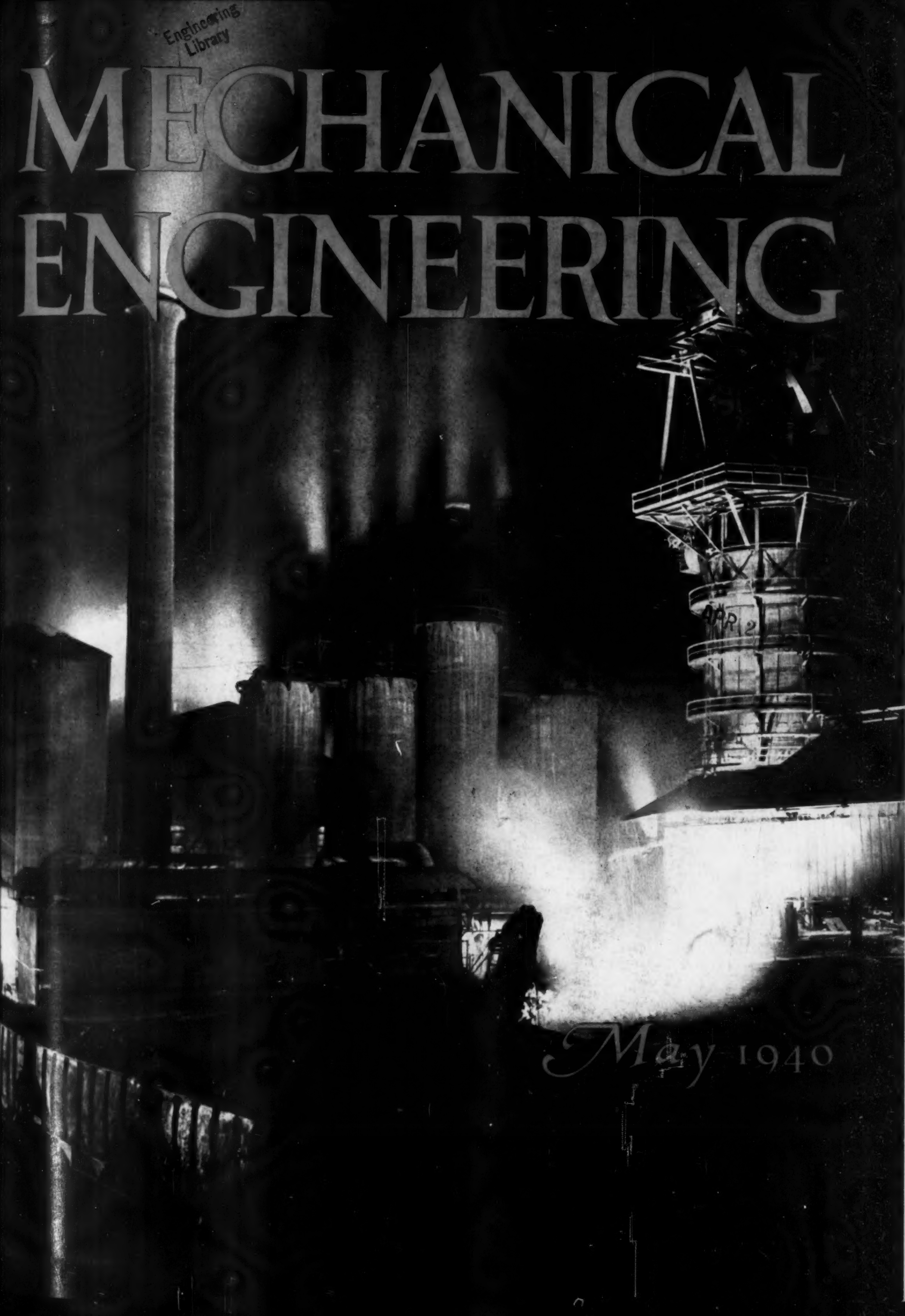
MECHANICAL ENGINEERING



May 1940

Why DID 97% ORDER *Bailey Meters*

Steam Generating Units of 700 Lb. Pressure and Over for Central Station Service, Ordered, Under Construction or Placed in Service during 1939

	Station	Company	Boilers	Capacity, Each Lb per Hr	Design Press. Lb per Sq In.	Total Steam Temp., F
✓	Oswego	Cent. New York Pr. Corp.	2	900,000	1500	903
✓	Windsor	Ohio Pr. Co.	1	750,000	1525	925
✓	Waterside	Consolidated Edison Co., N. Y.	2	615,000	1475	925
✓	Waterside	Consolidated Edison Co., N. Y.	2	615,000	1485	925
✓	Chester	Philadelphia Elec. Co.	2	600,000	1450	935
✓	Marion	Pub. Serv Elec. & Gas Co., N. J.	2	550,000	1475	950
✓	Burlington	Pub. Serv. Elec. & Gas Co., N. J.	2	550,000	1475	950
✓	Twin Branch	Indiana & Michigan Elec. Co.	1	550,000	2650	940
■	Buzzards Point	Potomac Elec. Pr. Co., Wash., D. C.	1	525,000	775	900
■	Lake Shore	Cleveland Elec. Ill. Co.	2	500,000	1000	910
■	Manchester St.	Narragansett El. Co. (Providepce)	1	430,000	1350	915
■	Northwest	Commonwealth Ed. Co., Chicago	3	425,000	1425	935
✓	Delray	Detroit Edison Co.	3	424,000	950	910
✓	Conners Creek	Detroit Edison Co.	3	420,000	710	840
✓	12th Street	Virginia El. & Pr. Co., Richmond	1	400,000	925	835
✓	Newcastle	Penn. Pr. Co.	1	400,000	900	900
✓	Cliffside	Duke Power Co.	2	400,000	900	900
■	Buck	Duke Power Co.	2	400,000	900	900
✓	John C. Weadock (Bay City, Mich.)	Consumers Pr. Co.	2	400,000	900	900
■	Chickasaw (Mobile)	Alabama Pr. Co.	1	400,000	950	860
✓	Bryce E. Morrow (Kalamazoo, Mich.)	Consumers Pr. Co.	2	400,000	900	900
■	Macon	Georgia Pr. Co.	1	400,000	950	860
✓	Toronto	Ohio Edison Co.	1	400,000	900	900
■	Commerce St.	Wisconsin Elec. Pr. Co.	1	375,000	1400	900
	L. Street	Boston Edison Co.	2	375,000	1400	910
✓	Millers Ford	Dayton Pr. & Lt. Co.	2	375,000	1375	900
■	Peoria	Central Illinois Lt. Co.	1	375,000	900	90
			1	300,000	900	87
✓	Powerton (Ill.)	Commonwealth Ed. Co.	2	450,000	732	75
			1	290,000[1]	732	75
■	Lake Road	City of Cleveland, O.	3	350,000	750	83
✓ ■	Cedar Rapids	Iowa El. Lt. & Pr. Co.	1	300,000	750	7
			1	250,000	750	7
✓	Westport	Cons. Gas & El. Co., Baltimore	2	285,000	1450	
■	Dresser	Dresser Pr. Corp., W. Terre Haute, Ind.	2	250,000	775	
	Goble Street	Houston Lt. & Pr. Co.	1	250,000	975	
✓	Station No. 3	Rochester Gas & El. Corp.	1	250,000	750	
✓	Ottawa St.	City of Lansing, Mich.	2	225,000	950	
✓	E. Wells St.	Wisconsin El. Pr. Co.	1	225,000	725	
✓	Evansville, Ind.	So. Ind. Gas & El. Co.	1	225,000	900	
✓	Avon (Calif.)	Pacific Gas & Elec. Co.	3	200,000	1525	
✓	Martinez (Calif.)	Pacific Gas & Elec. Co.	3	200,000	1525	
✓	Oleum (Calif.)	Pacific Gas & Elec. Co.	3	200,000	1525	
■	Municipal Plant	City of Glendale, Calif.	2	200,000	750	
✓	Blount St.	Madison Gas & El. Co. (Wis.)	1	200,000	975	
✓	Walnut (Groveport, Ohio)	Columbus & So. Ohio El. Co	2	200,000	1475	
✓	Abilene	Kansas Pr. & Lt. Co.	1	190,000	900	
✓	Rockford	Cent. Ill. El. & Gas Co.	1	175,000 (initial) 190,000 (future)	72	
✓	Hutsonville	Cent. Ill. Pub. Serv. Co.	2	150,000	72	
✓	Derby, Conn.	Derby Gas & El. Co.	2	125,000	72	
✓	Moose Jaw, Sask.	Natl. Pr. & Lt. Co.	1	120,000	6	
■	Oil City, Pa.	Keystone Pub. Serv. Co.	1	100,000	7	
✓	Alexandria, Va.	Virginia Pub. Serv. Co.	2	80,000	7	
	Lawrence, Kans.	Kansas Elec. Pr. Co.	2	60,000	7	

✓ PURCHASED BAILEY METERS

■ METERS NOT YET PURCHASED

COMBUSTION—January 1940

These projects, listed in the January, 1940 issue of Combustion, show current trends in steam plant engineering. Some are completed and some are still on paper, but all are new.

As of February 1, 1940, Bailey Meters were on order for 97% of the projects closed. This fact is significant to engineers responsible for the purchase of power plant equipment, because it indicates that Bailey Meters must offer unusual advantages to boiler plant operators. Some of the advantages offered by the Bailey Boiler Meter are:—

1. It is a dependable guide to maximum fuel economy under routine operating conditions.
2. It enables operators to secure the maximum steaming capacity from each boiler.
3. It shows operators when boiler tubes become dirty and then records the periods of tube blowing.
4. It prevents rapid deterioration of furnace wall refractories by warning operators when furnace temperatures may be excessive.
5. It is the heart of Bailey Meter Combustion Control. In this complete system it automatically readjusts fuel—air ratio so that optimum combustion conditions are continuously maintained without the necessity of periodic readjustments by operators.

Bailey Boiler Meters and Bailey Meter Control often return their entire cost in less than one year by the fuel and maintenance savings which they effect. Write for complete information as to how these "high return investments" may be made in your plant.

BAILEY METER COMPANY
1026 IVANHOE RD. • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada

D-34-1

BAILEY METER CONTROL

The Complete Combustion Control System

BOILER METERS • MULTI-POINTER GAGES • FLUID METERS • RECORDERS • SUPERHEAT CONTROL • DESUPERHEAT CONTROL • COMBUSTION CONTROL • FEED WATER CONTROL

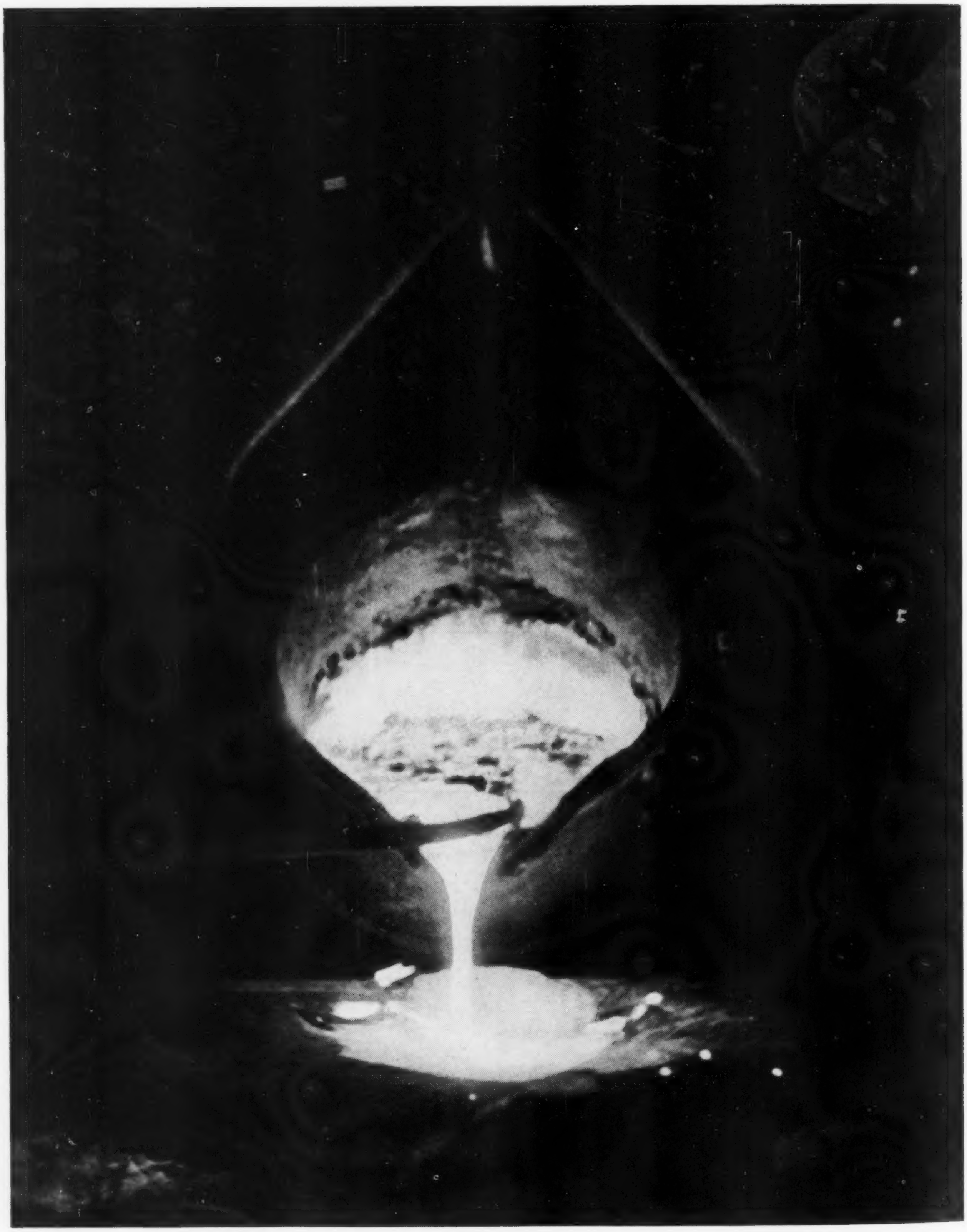
MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 62 NUMBER 5

Contents for May, 1940

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York, N. Y. Cable address, "Dynamic," New York. Price 60 cents a copy, $5.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage to Canada, 75 cents additional, to foreign countries, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Member of the Audit Bureau of Circulations.



"Casting"

(Photograph taken by W. F. Weiland and shown at the Fourth Annual Photographic Exhibit held during the 1939 A.S.M.E. Annual Meeting in Philadelphia.)

VOLUME 62
No. 5

MECHANICAL ENGINEERING

MAY
1940

GEORGE A. STETSON, *Editor*

Of Human Behavior

SOMETIME ago in these columns it was suggested that the source of certain frictions between management and workers lies in the actions and attitudes of the immediate supervisory forces through whom each group largely makes its contacts with the other.

The importance of these supervisory forces in the proper administration of industrial enterprises is brought out in this issue in a review of the report, "Management and the Worker," of the now completed experiments at the Hawthorne works of the Western Electric Company. Because these experiments were so thorough and comprehensive, and because they have been so carefully analyzed, their importance should not be lost on engineers and industrial executives. They remind us that there is more to manufacturing than methods and machines, and that men may prove to be the most difficult problem with which the executive has to contend.

In the review Professor Arensberg puts his finger on the crux of the problem. He says: "People at work in industry act as of the social groups to which they belong and as of their status in them. The logical concepts of management are not necessarily those of the workers, and programs for action, like incentive and efficiency schemes, are never wholly acceptable by those who must work them unless they fit also into the often seemingly illogical sentiments and ruling notions which govern action in the working environment among fellow workers."

In other words, this is the old admonition, "put yourself in his place," if you can, and it lends authority to the oft-repeated advice to young men to spend some time rubbing elbows with men in shops if for no better purpose than finding out how they think and act. Neither college nor industrial plant can afford to let young men skip over this experience by creating in them the impression that work at bench or machine is unnecessary, even for the very brilliant youngster who is undeniably destined for rapid advancement.

The Profit Motive

IT IS refreshing to hear a blunt but honest voice speak out on the necessity of making a profit in business. Mr. Kent does this in the very first paragraph of his stimulating article, "What the General Manager Thinks About," to be found in this issue. He puts the choice squarely up to us; either private industry, free competition, and the profit motive, or state socialism.

It is not necessarily their objectives that men quarrel about so much as it is means and techniques, and the profit motive is one of those techniques about which we find opposing opinions. In the narrow sense in which many reformers insist on interpreting it, the profit motive is the law of the jungle. In the broad sense in which most men engaged in business think of it, it is, paradoxically, only another term for "production for use." What is profit, and what is the profit motive? The words cover a wide range of significance. The profit motive may be a ruthless grasping of whatever is in sight for selfish and personal use without consideration of the rights or welfare of others. The world has seen and is seeing plenty of this. There is the profit that accrues to the general welfare of a group, a nation, or a race, and its attainment may be reached quite as ruthlessly as by the methods used by gangsters. There is profit that benefits the general welfare of mankind as a whole—that long-range concept of a better society that makes starry-eyed reformers out of some of us and hardheaded practical men of affairs motivated by enlightened self-interest out of others. The profit may be measured in units of money or material goods, in terms of power and influence, or in the satisfaction of self-sacrificing service to humanity and the dictates of conscience. It is not only the general manager who thinks about profits first, last, and all the time. It is every one of us, only the other fellow's idea of what constitutes profit and the means he adopts to secure it are never quite so good as our own.

Almost regardless of what course society may take toward the realization of individual or community profit, the engineer is likely to be one of the most important factors in the successful pursuit of profits. It would be possible to argue that the American system of free enterprise is suffering from a failure to make best use of the creative talents of engineers, in spite of the tremendous advances it has made under their stimulation. The argument would be that a world which has been revolutionized by engineers to a confusing degree finds itself dependent on engineers and needs an increasing amount of the contributions they can make.

The dynamic balance of a system cannot be maintained without making up for the losses of the energy it dissipates. The profits of an industrial system depend upon more efficient production and new opportunities for producing necessities and luxuries. Unless these new opportunities are created, the law of diminishing returns eventually reduces the margin of profit to the vanishing point. Cheap standardized goods may be produced in enormous quantities, but without the profit that is the incentive to continue the production. In a system of free

enterprise, this situation surely cannot last indefinitely.

If, then, as a result of this starvation of the profit system by failure to make best use of engineering talent in production technique and in research and the development of new products, free enterprise is threatened, one means of keeping it alive would be to increase the opportunities for engineers to exercise more effectively their creative talents. If the system should ever be replaced by collectivism or state socialism, the services of engineers would still be in demand, as has been amply demonstrated in Europe. Whether the engineer of the future will serve the state or a private employer under the system of free enterprise, only the future itself will show. But if those who believe in free enterprise and the profit system wish it to continue, industrial organizations will be wise to encourage engineers to exercise more abundantly their creative talents.

Industry's Greatest Resource

THE dilemma in which many young engineers find themselves excites the sympathy of the entire profession. It has been set forth in several of the letters on unionization that have been published in the correspondence pages of this magazine during the last few months. Briefly, it is this. The young men find themselves in a minority position in industrial employment. They have not yet firmly established themselves in positions where their individual talents have been augmented by years of practical experience. Except in rare cases, their reputations are yet to be made. Industrial executives are not actively competing for their services as they do for those of older men whose talents and performances may be exceptional and hence well known. Although it will be generally admitted that these young men will some day be filling a majority of the responsible positions, the period of internship grips them with its keen competition and its immediate uncertainties. It is the period in which every man must prove himself worthy of advancement. It is the period in which lucky breaks will condition the opportunities and rewards that lie ahead and constitute an additional factor to modify the progress honestly earned by real worth and accomplishment. This is one horn of the young engineer's dilemma.

From the other side these young men feel the pressure of powerful well-organized labor groups whose demands on the industrial pay roll are enormous and whose members have the backing of a large section of public opinion, public policy, and what in many cases appears to be almost ruthless economic power. Here the incompetence and mediocrity of the individual is protected from the free working of the law of supply and demand by submergence in a group. Join the union, pay the dues, and submit to the discipline of the group. Wages, hours, and conditions of work, seniority rights, and a host of other advantages an ordinary mortal cannot get for himself come to him as a dividend from his group. But the young engineer does not fit into any such group. This is the other horn of the dilemma.

It is easy to understand the confusion and, in many cases, the resentment of these young engineers. They have invested many years of their lives and much money in an education that they had a right to assume would make them more valuable to industry than untrained men would be. In a majority of cases the effects of a college education have probably been a livelier sense of social responsibility, a better understanding of economic and social relationships, and an ambition to make a success of life, to take responsible part in community affairs, and to improve the standard of living of the nation. Once employed, these young men have come face to face with hard facts, exasperating postponements of their ambitions, stupid injustices, and many of the unlovely qualities of human nature. In many cases they have found their wages, conditions of work, and security of employment but little better or even worse than men who perform routine, machine-like tasks, and who are ignorant of and uninterested in any sector of the general welfare except that in which immediate personal advantage lies. They begin to think of themselves as the forgotten men of industry. They look above and see the executive positions they may some day hold, if they can hang on long enough. They look below and see the great mass of workers who are organized to enforce their demands. What can they do about it?

It is in this mood and in the face of this dilemma that some young engineers turn to their national engineering societies for help. It is not the present purpose either to outline what the societies are doing or what they might do to be of help to these young men. In so far as technical interests are concerned, the present programs are fairly well known. The last few years have witnessed a great increase in activities under these programs. As to the interests that relate to economic status the societies' role is a relatively new one. Suffice it to say that the societies are rapidly increasing the attention they pay to this phase of the individual engineer's economic and professional welfare. The present purpose is to state the problem and to solicit interest in its solution.

Fundamentally, next to the young engineers themselves, industry has the greatest stake in the solution. It is a commonplace truism that the strength of an industrial civilization lies in its industries. It is less obvious, perhaps, but just as true that the success of an industry depends on the creative energies of its engineers, and potentially, at least of its young engineers—the men who will one day be the main source of these creative energies and of the nation's administrative talent.

The larger industrial plants have long recognized this. They have recruited their personnel among college graduates and they have instituted training courses for their young employees. Perhaps the hazards and discouragements of these early years in the young engineer's life are the necessary trials of his true worth. But perhaps, also, preoccupation with other matters—the cares of keeping a business solvent, the concern with new conditions in labor—have led to partial neglect of industry's most valuable resource—its young engineers. Undoubtedly this is true in many of the smaller plants. Is not the time ripe for a careful and sympathetic study of the position of the young man in industry?

Engineering Aspects of
TEXTILE TECHNOLOGY

By EDWARD R. SCHWARZ

PROFESSOR OF TEXTILE TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

FOR convenience, textiles have been divided into three classes according to usage, namely, materials intended primarily for dress, those intended for ornament, and those which are principally mechanical. For many years the engineer has been increasingly interested in mechanical textiles covering the range from the ventilating tube used in subway construction and in mines far underground to the airplane wing and the parachute overhead. At first his attention was principally directed toward determining tensile strength and later stretch properties. Now his interest has broadened to include not only the extension of simple strength determinations to investigations of repeated-stress and plastic-flow phenomena, and of simple stretch measurements to measurements of creep and creep recovery, but to the evaluation of permeability to fluids, thermal conductivity, electrical insulation, flexibility, abrasion resistance, crease resistance, compressional resilience, torsional equilibrium, and the effect of many variables incident to testing and research. Especially, in this latter field, has he found that the application of the statistical method has become a necessity.

It is increasingly evident to the textile technologist that these properties of textiles are after all the properties of matter in general and of engineering materials in particular. He realizes that the knowledge built up by engineers over generations of experience and experiment is of value to him. He recognizes the application of many engineering formulas to textile research and has been able to adapt much of engineering practice to his work, not only on fabrics and yarn but in the study of the ultimate structure of fibers as well.

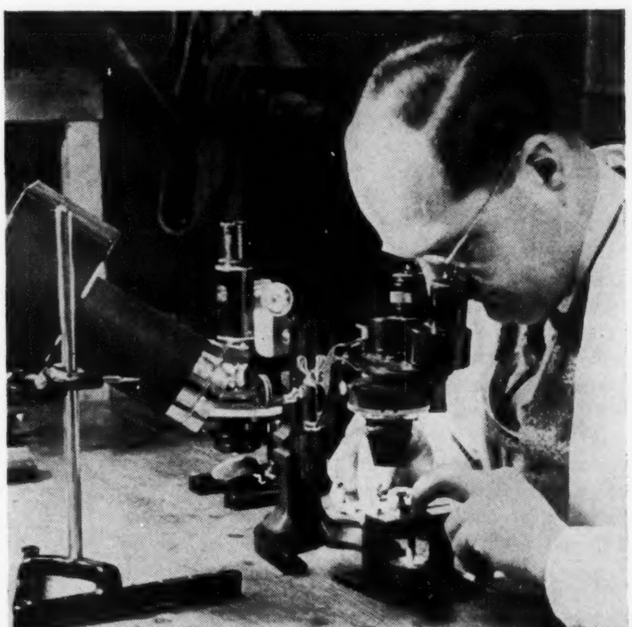
RESEARCH IN THE FIELD OF FIBER STRUCTURE

Nor is the matter wholly a contribution of the engineer to textile technology. Now as never before, the textile research worker feels that he has something to contribute to the engineering profession. Strangely enough, the most important contribution is likely to come from physical, chemical, and optical research in the field of fiber structure. But perhaps it is not so strange in the last analysis. For centuries the engineer has patterned his construction after Nature. The tree branch is a cantilever beam. The tree trunk is a column. The beaver dam is closely related in principle, differing only in degree, to the dams at Boulder Creek and Grand Coulee. In essence, the cotton fiber is a structure held together by means of spiral reinforcing rods made up of fibrils. The essential difference between this structure and the similarly reinforced concrete column is that Nature has dared far to exceed the limits of recognized engineering practice by building columns several thousand times as long as they are in diameter in order to achieve a large measure of combined flexibility and permanence. In the cotton fiber, Nature has also succeeded in achieving one dream of the engineer, namely, the combination of extreme lightness with extreme strength. Even though the density of cellulose as found in cotton is very much less, for its cross section the cotton fiber is as strong as many of the metals.

Not content with a study of the natural textile fibers, man has dared to synthesize his own filaments. In so doing, he has achieved more than the mere duplication of chemical substances in the natural fibers; he even hopes to produce fibers which will be similar architecturally. It is evident to the student of fiber structure that not only must he select his raw materials with as great care as to identity and specification of properties as would an engineer, but he must also build them into a proper arrangement as does the engineer. The finest steel procurable will not make a satisfactory bridge unless it is properly fabricated and properly placed. The purest of carbon, oxygen, hydrogen, and nitrogen will not make a satisfactory fiber unless they are arranged properly into molecules and unless the molecules in turn are properly bonded and properly placed in the final structure.

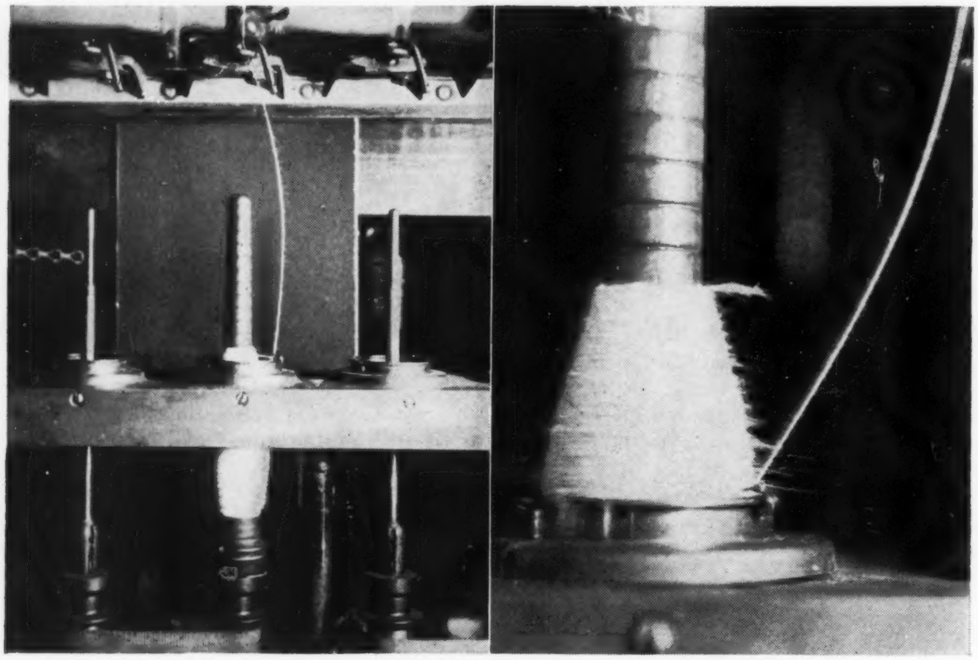
SIMILARITY OF STRUCTURAL AND TEXTILE STUDIES

As an aid to his investigation of the fabrication and placement of structural members, the engineer resorts to photoelastic analysis. He studies scale models of his structural elements made up of plastics and placed in a beam of polarized light to show the stress intensity and distribution. One of his major problems (now fortunately somewhat minimized by the ad-



PREPARATION OF RAPID METHOD (10 MU) CROSS SECTIONS OF FIBER FOR MICROANALYSIS

Contributed by the Textile Division and presented at the Annual Meeting, Philadelphia, Pa., December 4-8, 1939, of The American Society of Mechanical Engineers.



EDGERTON HIGH-SPEED PHOTOGRAPHS OF COTTON-RING-SPINNING SPINDLE IN OPERATION AT 10,000 RPM

vent of polaroid) is to produce a small-scale model which will behave as would the full-sized specimen. Similarly the textile technologist uses polarized light to study the structure and strained condition of fibers. His problem is the opposite one, however, in the matter of difficulty. His normal specimen is so small as to require a microscope to see it and the investigator in this field has to enlarge his specimen optically in order to study it. Here again the advent of polaroid has simplified certain of his techniques. He has the advantage over the engineer in that his actual material is itself transparent and rather highly doubly refractive.

Furthermore, the use of the microscope for the examination of the smallest resolvable detail of the structure of fiber, yarn, or fabric is paralleled by the use of the microscope by the investigator of wood, cement, or metal. What the microscope has done for the metallurgist it is also doing for the fiber technician. What it has done for the builder it has done for the spinner and weaver. As better and cheaper alloys have been made available for the engineer by microscopy, intelligently interpreted in the light of chemistry and physics, so better tires, belts, and ropes have been similarly made possible by the textile manufacturer for the engineer.

The heat-treating of metals has provided a wealth of valuable material for the industrialist. In textiles, moisture is to fiber what heat is to metal in industry. Fibers, too, may be annealed. Fibers may be "dry-worked" as metals are "cold-worked." Many of the problems of the textile manufacturer, which have been enhanced by the advent of rayon, have been solved in large measure by adequate understanding and control of humidity during processing. Wet-finishing of woolens and worsteds has much in common with the "soaking" of a steel billet.

X-RAY EXAMINATION OF FIBER STRUCTURE

As with the engineer, the textile technologist does not find that he must limit his work to investigations with visible light. The engineer makes a practice of examining many castings by means of X-ray photography to detect flaws which would not otherwise be apparent. X rays also serve to tell the research worker in fiber structure about hidden molecular faults in the filaments which he works. By means of the X-ray diffraction pattern and of the silhouette, he can determine the condition of fibers and yarns in the interior of a rope or fabric.

The familiar beam formulas of the engineering student have been adapted to the study of the flexing of yarns and fabrics. Certain techniques utilize the cantilever principle. Other methods employ the principle of the beam fixed at both ends, i.e., the continuous girder. In yarns a condition of torque equilibrium is often as important as is balance in a machine part. Such equilibrium produces a "balanced" yarn. The phenomena associated with flexural and torsional shear are apparent every time a piece of yarn or fabric is tested in a tensile machine. Slippage due to lubrication of fibers (or even of the elements of fiber structure) must be studied much as is any lubrication problem. Pressures of a magnitude, generally unrealized, occur regularly in yarns and fabrics and produce compressional effects which must be studied. This will be appreciated when it is recognized that a 10-g pressure of one fiber against another produces a localized compressional force in the order of magnitude of 100 kg per sq mm.

STRESSES IMPOSED BY MANUFACTURING PROCESSES

Not only is a study of frictional phenomena important for an understanding of yarn structure but also because of the fact that yarns and fabrics are constantly being subjected to the frictional resistance offered by guides and other surfaces during and after manufacture. The engineer of a textile plant must of necessity deal with the passage of textile products over and through a wide variety of materials and a surprising array of openings. In many instances this travel is at high speed and takes place while the textile is in anything but its strongest state. Anyone who has ever watched a high-speed warper wind thousands of yarns onto a giant spool or beam at the rate of hundreds of yards per minute realizes something of the problems involved in guiding each separate yarn into its proper place and at the correct tension. The handling of goods in a bleachery where festoons of fabric travel through a maze of pot eyes is another example.

After the fabric reaches the ultimate consumer, it is subjected to friction in many different ways. It must withstand abrasion to possess suitable durability. To measure the abrasive resistance, the ingenuity and the skill of the machine designer have evolved something like a score of testing machines. No two are quite alike but all attempt to evaluate certain fundamental changes brought about in a fabric as the result of wear. While many an engineer has devoted a lifetime of effort in the attempt to eliminate friction in combinations of moving parts, yet the same principles are being employed in reverse to produce known amounts of friction under controlled conditions for fabric testing.

HEAT-RESISTING AND INSULATING QUALITIES OF FABRICS

Conduction, convection, and radiation are terms familiar to every engineering student as a part of his work in thermodynamics. They are also important to the textile technologist because they mean so much to the ultimate consumer of textiles. Much effort has been directed toward the production of warmer and lighter fabrics. Now attention is being given to the manufacture of cooling materials. The problem is much more one of radiation and convection than of conduction. It has been repeatedly demonstrated that almost any kind of textile fiber can be used in a fabric and yet have the cloth show excellent resistance to the passage of heat.

It is inherent in a textile that there are many small air spaces or cells which, when air flow through them is minimized, constitute an excellent thermal insulator. Thus, the porosity of the fabric is important when considered in connection with the permeability of the goods to air. Its permanence is also of considerable importance and, in this respect, the merit of wool or heat-insulating materials of textile nature becomes apparent. Wool fiber is naturally resilient and will maintain a sufficiently constant degree of porosity within a fabric structure to endow it with highly efficient insulating value over long periods of time. Initially, other fabrics made of differing types of fiber may have the correct porosity and permeability to be excellent insulators but, in general, these characteristics fail to endure over periods of service to the same extent as in the case of woolen or worsted materials.

Engineering is continually brought in contact with seeming anomalies. This instance is no exception. A material may be extremely porous and have a high permeability to air when the surfaces (or one of the surfaces) are exposed to moving air. But, if this same material be placed in such a condition that it is surrounded by still air or, otherwise, that the passage of air through it is obstructed, it may become an excellent nonconductor of heat.

PERMEABILITY TESTING OF FABRICS

The greatest of care must be exercised in testing to be certain that conditions of service are reasonably duplicated. For this reason, permeability tests go hand in hand with heat-transmission tests. It has been found that studies of the flow of fluids through orifices can be applied to permeability testing, and it is an engineering achievement to design and build a satisfactory permeability tester. Initial work with such devices has demonstrated that effective use may be made of the Reynolds number and the Fanning friction factor in computing what is happening in such materials. Some types of machines depend for their operation upon measurements of air-velocity changes as a stream of air passes through the cloth. Others measure the volume of air passing through a known area of the material under controlled conditions of temperature, pressure, and humidity in a given time. Usual conditions range from 0.01 cfm to 40 cfm and, particularly, at low rates of flow, the "hairiness" of the yarns composing the cloth becomes of great importance.

For as many years as the use of electrical devices has been general, textile materials have served as insulators. During this same period, extensive research has been devoted to investigating the properties of these materials and to improving their performance. In this connection, the work undertaken by the Bell Telephone Laboratories has been particularly productive of important and interesting information. Much of it may be considered as the by-product of pure research and, in this classification, is the work on moisture absorption of textile fibers. A dry fiber is an excellent insulator, but one containing moisture picked up from the atmosphere rapidly loses its effectiveness in preventing flow of electrical energy as the moisture regain increases. The mechanism of moisture absorption is complex and not yet fully understood but, as a result of an engineering application of fiber, yarn, and fabric to electrical insulation, the remaining mystery may be fully cleared up.

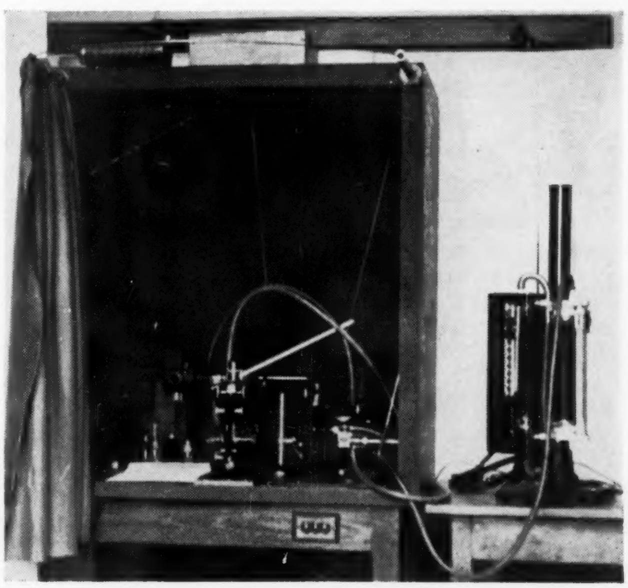
The automotive industry has made use of fabrics and yarns for years and continues this use in the latest model cars.

IMPORTANCE OF THE QUALITY OF RESILIENCE IN TEXTILES

The textile technologist has had his attention called to the importance of a phase of testing which hitherto has been rather badly neglected. At least indirectly, this warning has come from the automotive industry. Resilience or the recovery from compression is vital to the proper functioning of the spring suspension of an automobile. Resilience in much the same sense is an equally vital quality in the textiles used to stuff mattresses and pillows as well as in those used for floor and furniture coverings. While it may be argued that one cannot push on a rope and, hence, need not worry about compression testing of textiles, the tire manufacturer joins the carpet manufacturer in disagreeing. As a result, effort has been devoted to design, construction, and use of textile compressometers, resilience testers, and thickness-measuring devices, all employing pressure. If the results of certain compression tests are plotted, interesting and informative hysteresis loops are obtained. Energy changes and losses which are involved during such tests may also be studied. Such investigations are increasingly fruitful.

From resilience of fiber mass or pile surface, it is not too great a step to a consideration of the measurement of the crease resistance of fabrics. Many materials are being subjected to treatment with resins in order to improve their resilience under folding and flexing stresses. For such measurements, a compression tester is employed. The results of work in this direction, carried out at the National Bureau of Standards recently, have been correlated with the crushability of materials as determined manually.

The textile technologist along with the engineer is also realizing that perhaps too much emphasis has been placed upon the breaking load of materials as contrasted with the behavior of the material under small repeated stresses. Again, the tire



OPTICAL APPARATUS DESIGNED FOR RESEARCH RELATING THE MOLECULAR STRUCTURE OF FIBERS TO THE PHYSICAL PROPERTIES—PARTICULARLY OF CREEP AND CREEP RECOVERY

manufacturer has pioneered in this field and finds himself much more concerned with the life of tire cord subjected to repeated stresses much lower in magnitude than the ultimate stress than he is with the ultimate breaking load. Repeated flexing produces an internal abrasive action which may eventually cause failure. Just as the tester is wholly uninterested in conducting an abrasion test which shall cause total destruction of the sample in a single stroke, so the worker with tensile and compressive forces is becoming totally uninterested in single pulls to rupture.

EFFECT OF ALTERNATE STRESSES ON FIBERS

Such investigations cannot be conducted over any length of time without bringing up the question of behavior of fibers under small strains which are alternately applied and removed. Work is being sponsored at the Massachusetts Institute of Technology by the Textile Foundation in an attempt to correlate optical and physical evidence of creep and creep recovery, as well as plastic deformation, with the nature and degree of molecular orientation within the fiber. Thus, familiar engineering technique is making possible advances into the unknown realm of ultimate fiber structure. This is but another debt owed to the engineer by the textile research worker.

All these devices and techniques are combining to demonstrate that there seems to be a definite self-contained parallel in textile structures. Yarns are twisted from fibers. Fibers are twisted from fibrils, the last fiber-like structure visible in the microscope. Fibrils are made up of molecular fibers each one of which is a long-chain molecule, designated by one popular writer as "molecular chain gangs." Even as Nature spins molecules to fibrils and fibrils to fibers, man not only spins fibers to yarns and yarns to cords, but is himself spinning molecules into rayon, vinyon, lanital, and nylon.

COMBINATION OF MOLECULAR ELEMENTS IN SYNTHETIC FIBERS

In this spinning, the problem is not what materials to provide. The bricks of the structure are carbon, hydrogen, oxygen, and nitrogen. It is rather how they shall be combined. The difficulty is that which confronts the engineer in the specialized field of architecture. The analogy is quite apt, for the production of a satisfactory synthetic fiber is essentially a matter of architecture. It is a matter of arrangement of atoms and molecules, not so much their selection. Indigo dye is made of carbon, hydrogen, oxygen, and nitrogen and so are wool and silk. But there can be no confusion as to the identification of the dye as distinct from the fibers which it colors. The arrangement of the atoms in indigo produces a very satisfactory dyestuff. A different arrangement of these same atoms produces silk, still another produces wool, and a third results in nylon. Similarly horn and feathers represent further alterations in methods of combining these elements. The scientist may not know why the sheep is clothed in wool rather than in silk or feathers but, through intelligent application of fundamental engineering principles, he is well on his way to find out and explain the important peculiarities of the structure of each.

Like the engineer, the textile technologist must have a smattering at least of many sciences. He must be something of a mathematician, physicist, chemist, botanist, biologist, and statistician all rolled into one. No longer can a sharp dividing line be drawn between chemistry and physics. And, in the field of textiles, at least, there is developing a closer and closer association with and among the sciences which deal with life processes. The botanist and the biologist have much to contribute to the knowledge of the formation of the vegetable and animal fibers which are brought into being as the result of life processes by living organisms. Even as the engineer is increasingly seeking the help of the chemist and physicist as in the field of metallurgy, to mention only one instance, so the textile technologist must join hands with the biologist and the botanist. If he is wise, he will not only gladly receive their contributions to fundamental knowledge of fiber structure and growth but he will enthusiastically welcome the use of the statistical method which they have so long and so fruitfully employed. The method is invaluable in the laboratory to govern efficient planning of experiments. It is invaluable for the proper interpretation of data both as to correlation of trends and for the analysis of variance. Further, it should be extended to embrace quality control in manufacturing and to aid in production-control studies.

Whether it be in the measurement of physical properties of materials by the techniques of engineering, or the interpretation and application of the results of research for the benefit of the manufacturer, the textile technologist has merged himself as has the engineer in what the late Arthur D. Little called "the fifth estate . . . . composed of those having the simplicity to wonder, the ability to question, the power to generalize, the capacity to apply. It is, in short, the company of thinkers, workers, expounders, and practitioners upon which the world is absolutely dependent for the preservation and advancement of that general organized knowledge which we call science."

TESTING MACHINE FOR AUTOGRAPHIC RECORDING OF LOAD-STRETCH CYCLES FOR SINGLE STRANDS OF YARN

Making Better
MACHINE-TOOL CASTINGS

By F. J. DOST

SUPERINTENDENT, STERLING FOUNDRY COMPANY, WELLINGTON, OHIO

PERHAPS in the last 10 or 12 years more progress has been made in the manufacture of high-quality machine-tool castings than in the previous 20-year period, both from the angle of foundry technique and metallurgical requirements of the industry.

The progress in foundry technique is generally known, and information on the problems of sand control, molding, and cleaning methods is available in the form of American Foundrymen's Association Transactions or in the technical press. The method of application depends upon local conditions and organization personnel and will not be dealt with further in this paper.

In recent years, cast-iron metallurgy has progressed at a fast rate in most industries, primarily from the standpoint of strength and hardness. However, comparatively little work has been done by the machine-tool industry as a whole on the problem of wear resistance since the inception of high-strength iron. It is, therefore, the intention of the author to relate the experience of his company in improving the quality of machine-tool cast iron.

Until about 10 years ago, the conventional so-called "semi-steel" mixtures of 25–50 per cent steel of the high-carbon low-silicon type were being used for cast beds, frames, and sliding members but, where both heavy and light sections were encountered in the same castings, not altogether satisfactory results were obtained. If the mixture was adjusted to give a dense structure and high finish in the heavy sections, oftentimes hard corners and edges resulted on the lighter sections. Conversely, when the mixture was adjusted to make the light sections machinable, the heavy sections were not as dense nor the machined finish as good as desired.

By employing the use of nickel in this type of iron as a stabilizer, we were better able to control these variations. However, at this period little or no attention was given to the total carbon content just as long as the macrostructure was satisfactory. As a rule, this was governed entirely by adjusting the silicon to the metal section. Usually, upper and lower limits of silicon were set as standards for certain sizes of castings but, when the carbon (which was not analyzed too frequently) varied parallel up or down with the silicon, either open-grained or hard castings resulted. This gave the foundry a very narrow band of silicon range to maintain and necessitated frequent changes in the mixture.

As a result of these fluctuations and the increased demand for even more uniform castings, better finish, and greater wear resistance, the high-strength type of iron was adopted. This iron consisted of mixtures having 70–95 per cent steel content with low carbon and high silicon; just opposite to the semi-steel conditions. Table 1 shows a comparison of the two irons for the same size casting.

The high-strength or low-total-carbon iron showed very marked improvements, as a much higher machinable hardness was obtained, as well as excellent finish and less sensitivity to heavy and light sections in the same casting. The iron was dense in 4-in. sections and machined readily in $^3/_8$-in. sections, even though the Brinell hardness showed a decided increase over the high-carbon low-silicon iron.

TABLE 1 CHEMICAL COMPOSITIONS OF OLD- AND NEW-TYPE IRONS FOR SAME SIZE CASTING

20–50 Per cent steel		70–95 Per cent steel
3.25–3.50	Carbon	2.70–3.00
1.10–1.25	Silicon	1.85–2.25
0.60–0.70	Manganese	0.70–0.90
0.10–0.30	Phosphorus	0.20 max
0.08–0.12	Sulphur	0.10 max
1.00	Nickel	1.00–2.00
163–187	Brinell	207–269

It was also found that one mixture, or composition, of low-carbon iron would now suffice where two or three mixtures of the high-carbon low-silicon iron had been required before. This was due to the lower sensitivity to metal section.

As more experience was gained with this iron, it was found that by controlling the carbon at the lower limits of Table 1, 2.70–2.85 per cent, still higher hardnesses could be obtained in the range of 241–269 Bhn, and an excellent machined finish could be produced.

From every standpoint, good machinability, high hardness, excellent machined finish, and higher rigidity with less freedom from warpage without aging, this type of iron appeared to be ideal, with but one exception. This was an occasional case of scoring or galling of the wearing surfaces or ways. While the frequency of this scoring or galling was very low, it presented a new problem with which we had had no previous experience.

When the first case of scoring or galling was brought to our attention, an investigation was started which later led to a comprehensive study, involving about 2 years' work. This entailed making approximately 10,000 chemical determinations and 4000 microscopic examinations.

INVESTIGATION ON SCORING OR GALLING OF WEARING SURFACES

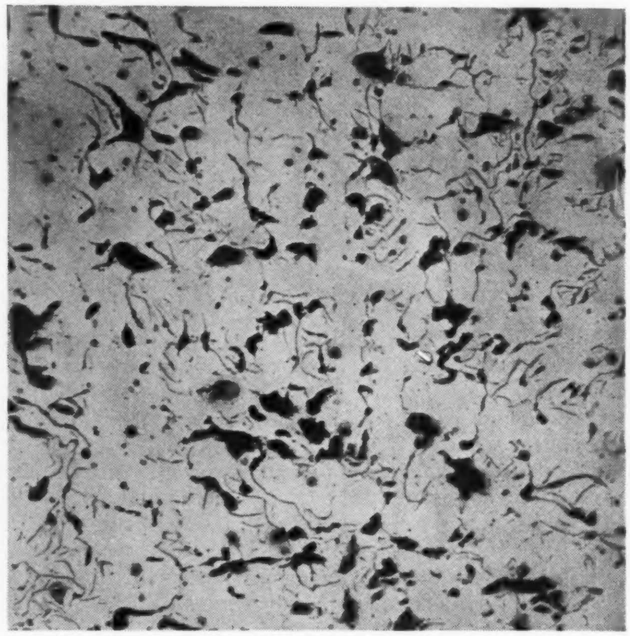
The procedure followed in this study was to take microscopic specimens from the wearing surfaces of both the bed and the immediate sliding member of the machine in question, and to examine the structure at the actual wearing surface. We also made a chemical analysis to correlate composition with this structure. Our first findings are illustrated in Fig. 1.

It will be noted in Fig. 1, that *A* shows a dendritic pattern and that, instead of having a flake-graphite, it has a nodular formation. Unfortunately, *B* is only 100× and does not resolve the matrix in complete detail. Examination at 500× shows the light-gray areas as very fine pearlite. The constituent circled will be discussed subsequently. Mostly nodular graphite is shown in *C*, although there is some flake present. A slight dendritic pattern is noticeable. In *D* the same specimen is shown etched, also 100×.

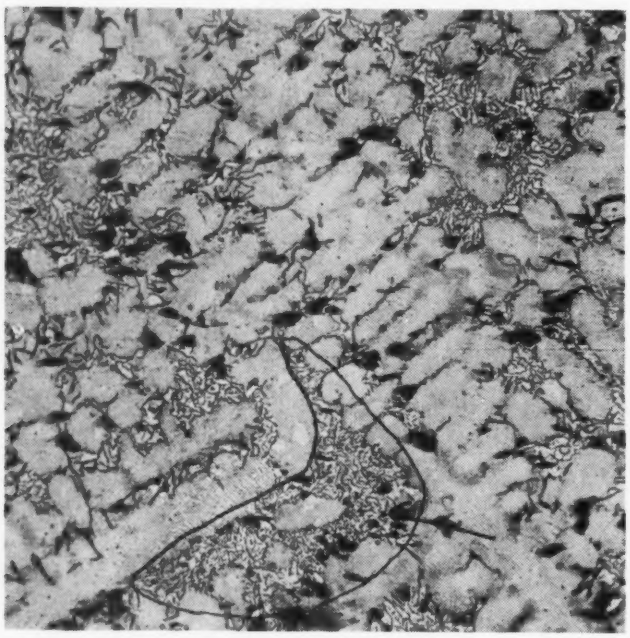
Subsequent cases of scoring or galling were treated in the

Contributed by the Machine Shop Practice Division for presentation at the Semi-Annual Meeting, Milwaukee, Wis., June 17–20, 1940, of The American Society of Mechanical Engineers.

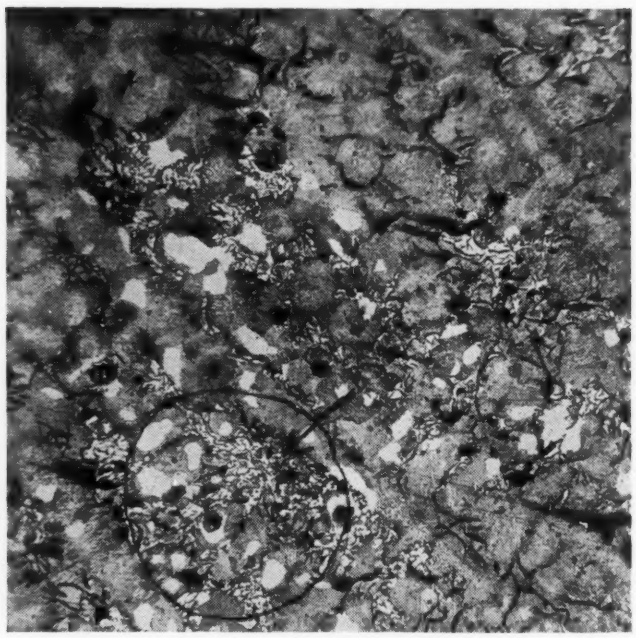
A, bed of lathe, 100× unetched



C, saddle of lathe, 100× unetched



B, bed of lathe, 100× etched



D, saddle of lathe, 100× etched

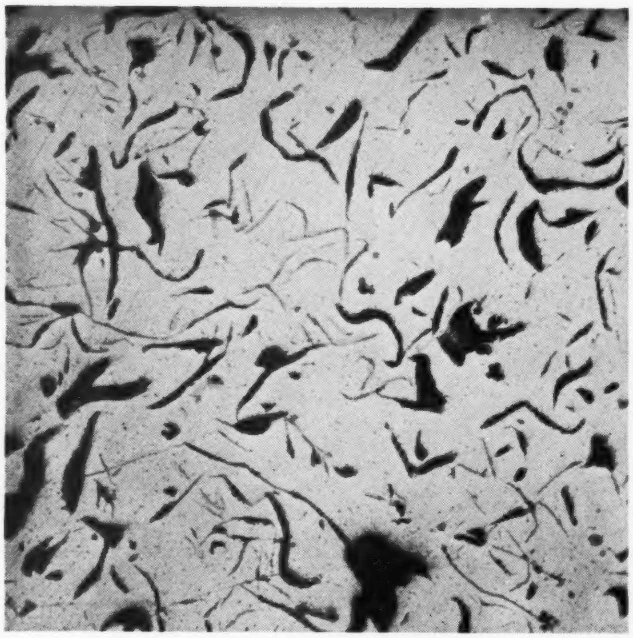
FIG. 1 PHOTOMICROGRAPHS OF SPECIMENS TAKEN FROM WEARING SURFACES OF LATHE

same manner. All the findings indicated that either the bed or saddle, or both, had a dendritic pattern. We also found that accompanying this dendritism was a peculiar type of constituent to which reference will be made later.

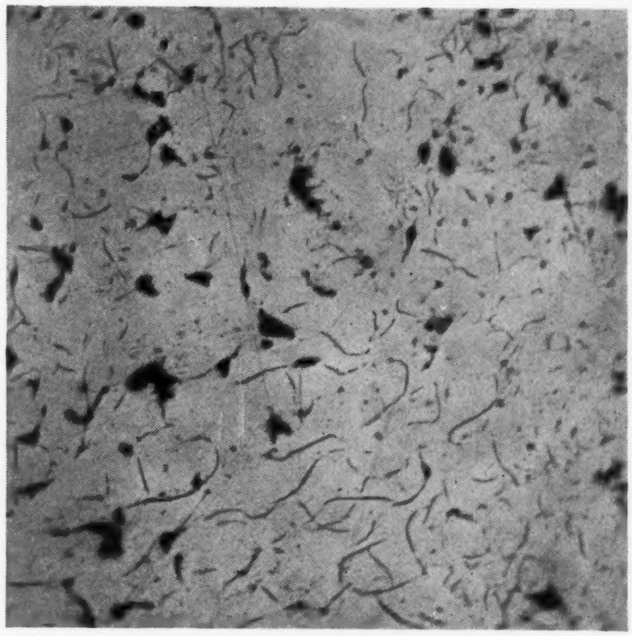
Our next step was to investigate the reason why machines cast in the same lot of the same mixture were giving satisfactory results. Fig. 2 shows photomicrographs made from specimens taken from the machine in service. In Fig. 2, *A* clearly shows a flake-graphite formation well distributed; *B* is the same specimen etched and shows a fully pearlitic structure. When examined at 500×, it shows this more clearly. In *C* both nodular and flake formations are shown, the flake being considerably finer than in *A;* *D* shows the same iron etched, bringing out a slight dendritic formation with a pearlitic-sorbitic matrix, but none of the peculiar constituent indicated in *B* and *D*.

It was then decided to investigate machines which had been in service for 15 or 20 years and had worn gracefully without scoring, and generally had given satisfactory service. The same procedure was followed as in the previous cases. Fig. 3 illustrates a representative set of conditions for this class of iron, which gave a porous finish, as well as a low hardness.

In Fig. 3, *A* shows a large graphite-flake formation, while *B*, the same iron etched, shows a ferritic-pearlitic matrix. A coarse graphite formation is shown in *C*. In the etched condition it is very evident that the matrix is nearly 100 per cent ferritic. A new constituent has entered the picture, namely,

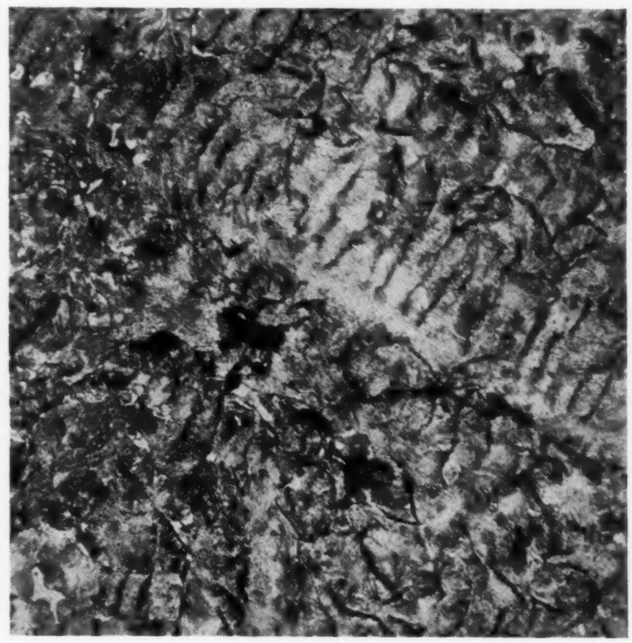


A, bed of lathe, 100× unetched



C, saddle of lathe, 100× unetched

B, bed of lathe, 100× etched



D, saddle of lathe, 100× etched

FIG. 2 PHOTOMICROGRAPHS OF WEARING-SURFACE SPECIMENS TAKEN FROM LATHE IN SERVICE

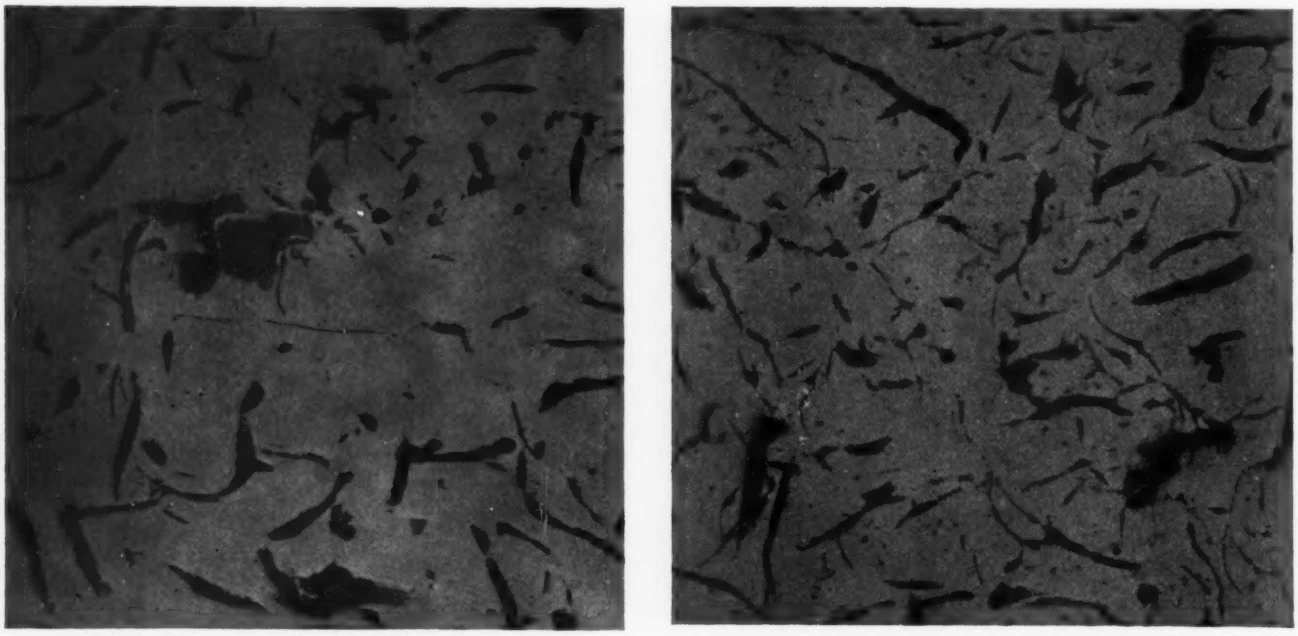
secondary ferrite. But regardless of this, the machine did not score or gall even though it did suffer considerable wear.

It should be emphasized that the foregoing illustrations are not of one machine but are representative of the entire investigation.

Since the peculiar structure seen in Fig. 1, *B* and *D*, was found only in cases of scoring or galling, while none of the machines giving satisfactory performance showed this constituent, it was logical to assume that we had a clue to its cause. This type of structure has been variously referred to as "primary ferrite," "eutectic," "pseudo-eutectic," "supercooled," "snowball," etc. The nature of the constituent is a fine ground mass of ferrite and graphite, which is soft, or mushy, comparatively speaking, and easily dislodged from the parent metal by sliding friction under heavy loads.

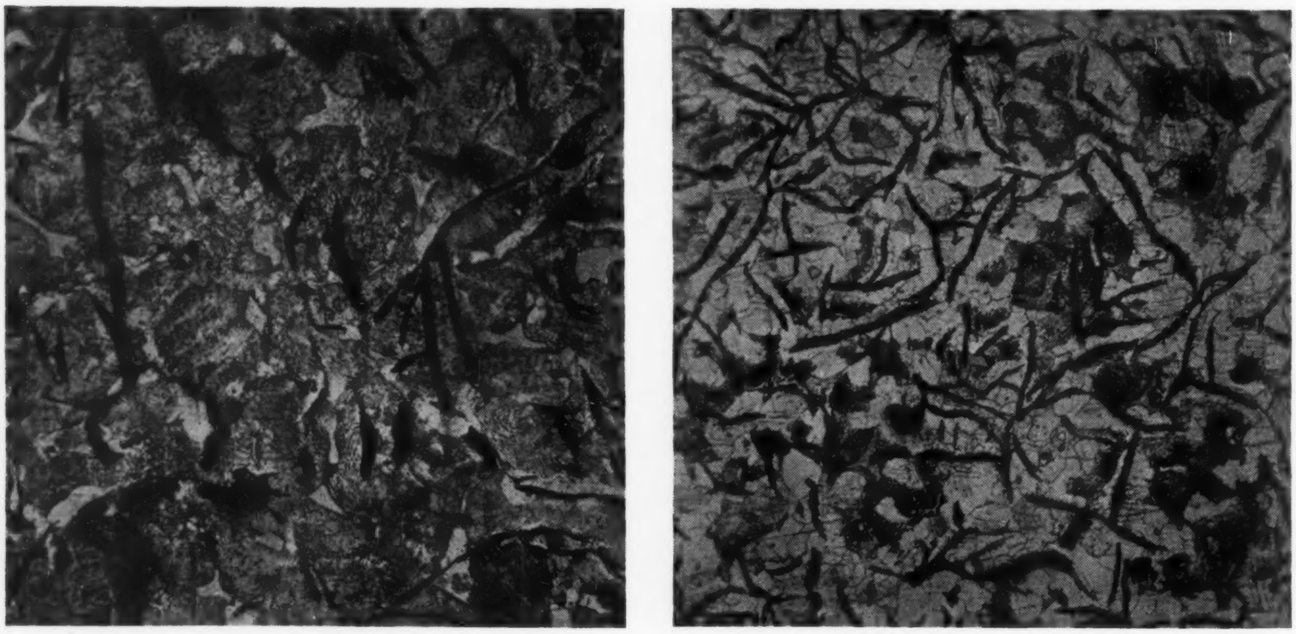
A scientific and comprehensive study of the formation of primary ferrite can be had by referring to recent papers[1] presented before the American Foundrymen's Association. Several other investigations on the subject have been reviewed in similar papers, most of them having been published in the American Foundrymen's Association Transactions. The bal-

[1] "Ferrite, Its Occurrence and Control in Gray Cast Iron," by R. H. Bancroft and A. H. Dierker, and "Graphitization and Inclusions in Gray Cast Iron," by J. W. Bolton, Transactions, American Foundrymen's Association, vol. 45, 1937, pp. 449–466 and 467–544, respectively.



A, bed of lathe, 100× unetched

C, saddle of lathe, 100× unetched



B, bed of lathe, 100× etched

D, saddle of lathe, 100× etched

FIG. 3 PHOTOMICROGRAPHS OF WEARING-SURFACE SPECIMENS TAKEN FROM LATHE IN SERVICE FOR 15 TO 20 YEARS

ance of this paper will deal with the solution of the problem as it was worked out in our foundry.

ELIMINATING PRIMARY FERRITE

Having found a clue to its cause, the problem now appeared to be one of eliminating or controlling the structure in order to free it of this primary ferrite and insure predetermined satisfactory wear, free from scoring or galling. However, before this was possible, the reasons or causes for its formation had to be found.

The opinions put forth by some investigators were that any given iron has a definite range of cooling rates within which a normal pearlitic structure will be formed. Cooling rates higher than this range tend to form primary ferrite or free cementite; slower cooling rates tend to form secondary ferrite. It was also revealed that primary ferrite areas were found in castings, the carbon content of which was somewhat below normal, and irons heated to 2850 F or over would show a greater tendency toward production of primary ferrite than similar irons heated to a lower temperature, even though the pouring temperature remained the same.

In comparing these findings with our practice, we found that we were producing low-total-carbon irons (2.70–2.85 per cent) and that we were melting at the higher temperatures of 2840 F and over, both practices conducive to primary ferrite formation. What to do was a problem since we wished to

FIG. 4 PHOTOMICROGRAPHS OF SPECIMEN IN WHICH FLAKE-GRAPHITE FORMATION HAS BEEN INDUCED, 100X

maintain the high degree of finish and hardness afforded by the low-carbon content as well as its flexibility for covering a wide range of casting sections. Also, we had to melt at the higher temperatures to avoid misruns in the lighter sections due to the higher freezing point or shorter life of the low-carbon iron. At this stage of our work, very little information was available about the control features of this structure, so the only solution apparent was an experimental program.

Our first experiments consisted of late ladle additions of amorphous graphite on the basis that we might possibly induce flake formation by "seeding" or the introduction of graphite nuclei. This treatment resulted in a definite improvement. Fig. 4 illustrates the graphite formation of this iron. This shows a medium graphite flake evenly distributed without a distinct pattern arrangement. The etched specimen showed practically all pearlite with a small trace of secondary ferrite. No primary ferrite was present. This treatment was followed for several months with promising results in that the amount of primary ferrite areas were reduced. These areas now seemed to be more isolated at the cast surface, with a penetration of $^1/_{32}$ to $^5/_{32}$ in. Beyond this depth there was practically no formation, the structure being normal graphite and pearlite.

Our next experiments consisted of supplementing the amorphous-graphite additions with ferrosilicon in varying proportions. The silicon being a graphitizer would affect the cooling rate and act as a mild deoxidizer at the same time. These combinations had their merits and produced equally good results and in some cases an improvement.

Following along the same lines, we used a commercial compound of silicon and carbon in varying percentages. This also produced good results in that we were able to keep the primary formation at the cast surface. After using this treatment for a sufficiently long period to build up some data, we adopted several combinations of ferrochromium and ferrosilicon.

The chromium, being a carbide-forming element, and the silicon, being a graphitizer, enabled us to change the cooling rates of the base composition. While our work on this phase of treatment was not extensive, we did obtain sufficiently good results to warrant further work as soon as time permits.

At the present time, we are developing data on straight ferrosilicon additions, using a coarse mesh of $^3/_4$ in. on $^1/_4$ in. In this particular case we have reduced the silicon in the base mixture by 25 to 50 points and replaced this amount in the spout as a ladle addition.

While the ultimate aim is to be able to establish conditions which will completely eliminate or minimize the formation of primary ferrite, we feel that sufficient data have been accumulated to enable an effective control of the depth of formation. This control feature gives every indication of being the difference between a casting which may score and one which will not score since, if all the primary ferrite is removed in the machining operation, we have a normal structure at the wearing surface.

To substantiate these findings an extensive wear test has been conducted, the results of which are shown in Fig. 5. Each curve represents the average of twelve readings and is read as weight loss per hour. Interpretation of these curves is that the greater the weight loss, the poorer the wearing qualities.

The curve, designated "*G* on 1106," is the result of a wear test on an iron "*G*" with excessive primary ferrite, and "1106" a normal bed iron without any primary ferrite. The weight loss is 195 mg in 1 hr, which would indicate very poor wear or possibly a very severe case of scoring. The other curves show from 21 to 33 mg for the first hour and represent irons with a normal type of structure free from primary ferrite, and also represent structures of machines giving satisfactory performance free from scoring.

Correlating these test data, we feel that, with the proper degree of control, both in the foundry and in the laboratory, cast iron with its inherent high damping, castability, machinability, and wear-resistance properties, now represents an ideal material for machine-tool castings.

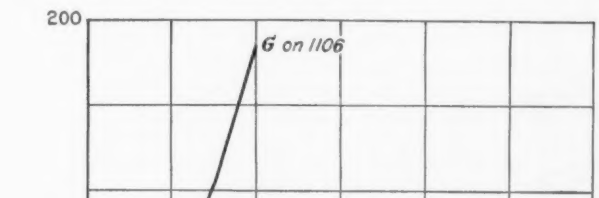


FIG. 5 RESULTS OF WEAR TEST, GIVING WEIGHT LOSS PER HOUR

WHAT THE GENERAL MANAGER THINKS ABOUT

By ROBERT THURSTON KENT

GENERAL MANAGER, WILLIAM SELLERS AND COMPANY, INC., PHILADELPHIA, PA.

WHAT does the general manager think about? First, last, and all the time, profits. Everything else stems from that. He thinks about a lot of other things, such as budgets, sales policies, shop methods, public relations, labor relations, the Wagner Act, the Wage and Hour Law, how he can get more help, costs, collections, credits, and in an engineering concern, engineering problems in all their phases. He also thinks about market analyses, not only for new products that he is considering, but also for products that are already being made. He thinks about what his competitors are doing. He tries to forecast what improvements in product they will be making in the next year, or five years, and he thinks about how he can beat them to it. But if there are no profits, he will not very long have to think about any of these things, for with lack of profits his company will, within a longer or shorter time, fold up and die. The general manager then will join the great army of the unemployed, and what he thinks about most then will be how to find a new job for himself.

PROFITS—THE PRIME CONSIDERATION

A few weeks ago I was talking with a group of men and indicated to them that I had been invited to come up to Cornell and address you young men. I stated to these men that I could sum up this entire address in one word—profits. These gentlemen were horror stricken at the idea of my boldly coming out and saying that profits were the prime consideration of management. In these days of unrest and baiting of business they thought it would be highly dangerous to mention anything so sordid as profits, especially to a group of young men just starting out in life. I have no apologies to make for making profits the central theme of what I intend to talk about today. So long as this country operates under the economic system under which it has grown to greatness in the last one hundred and fifty years, namely, private industry and free competition, the profit motive is absolutely necessary to its existence. The only alternative to profits is, in the long run, state socialism, and if we wish to forego profits we must look forward to the same kind of existence as the people of Germany and Russia have today, where every man does what he is told whether he likes it or not.

I said a moment ago that I had no apologies to make for speaking of profits. I will go even further than that. I believe that industry has too long been pussy footing in fear of offending politicians, radicals, and those who may temporarily be in power. If we believe in anything we should not be afraid to stand up and defend it. I believe in private industry, in free enterprise, and the profit motive, and I am willing to stand up and defend these principles before all comers. I think that it is a very healthy sign, not only for American industry, but for the American system and the American people as well, that the leaders of industry are beginning to get over their fear of being unpopular and are defending their acts and laying down a definite program for the betterment, not only of industry but of society as a whole.

FIRST PROBLEM IS VOLUME OF SALES AT A PROFIT

Having gotten this little sermon on politics or economics, as you may choose to call it, off our chests, let us now proceed to a more critical examination of the detailed problems of the general manager. His first problem is to be sure that there will be a sufficient volume of sales of his company's product at such a margin of profit as to enable him to buy the raw materials necessary to make the product and to meet the pay roll of the men who fabricate this raw material into finished product. He is not a free agent in determining what he shall charge for his product. It is a theory taught in some textbooks that the selling price should be the cost of production, including a reasonable amount for burden or overhead, plus a desired percentage of profit. This would be fine if he were permitted so to operate. As a matter of fact, the average manufacturer has little or nothing to say about what his prices shall be. They are fixed by the general market price of his product, or in other words, by his competitors. If he cannot manufacture at a cost that will, after the proper amounts for depreciation and all the other overhead charges have been set aside, permit him to have something over with which to pay dividends to his stockholders and to provide for a surplus for plant expansion and the inevitable rainy day, he may do one of two things: First, he may set the price of his product at a point that will, on paper, yield him a profit, which price will be higher than that of his competitors. In such an event he soon will make no sales and then he will have no income with which to meet either pay roll or dividends. At this point he will join the ranks of the unemployed. The second course that is open to him is to make a drastic revision in his manufacturing methods and possibly in the design of his product so that he can then manufacture at a cost that will enable him to earn a profit. I shall speak of this phase of the general manager's job a little later. At the present moment we are concerned with the forecast of possible income and the balancing of this income against the expected expenses. In short, we are now going to consider the budget.

WHAT IS A BUDGET?

What is a budget? It is simply a breakdown under certain well-recognized heads of the expected income in a given period, usually a year, and of the expenses, also broken down into an appropriate classification, that will be incurred in running the business. The income in the ordinary manufacturing concern will result almost entirely from sales. The general manager will call on the head of the sales department at the budget-making period, usually a couple of months before the beginning of the fiscal year, to give him an estimate of the volume of sales that reasonably may be expected in the next year. The sales manager, through his close contact with the customers and through his knowledge of the market from the salesmen's reports and from other sources, usually can forecast, within ten per cent

An address delivered to engineering students of the senior class, Sibley College, Cornell University, Ithaca, N. Y., Feb. 17, 1940.

one way or the other, the number of units of each type of product that he expects to sell during the coming year. These quantities multiplied by the unit sales price give the total dollar income that the general manager can count upon. But the sales manager must do more than furnish figures of total volume. He must show the fluctuation in sales volume from month to month so that the general manager will know what his cash requirements will be at any period of the year to meet pay rolls, purchase raw material, and meet all the other expenses that go into the running of a business.

For example, in a seasonal business with, let us say, two sales peaks each year, in the spring and fall, the cash inflow will be heavy from the beginning of March through May and from the beginning of September until the end of October and will be almost nil during the other months. Nevertheless, during these months of low cash inflow the expenditures of this particular business will be heavier than at any other time, because this is the period when manufacturing must be carried on at its greatest volume, when raw material must be purchased, when pay rolls must be met, when salesmen must be put on the road, and when a host of other heavy expenses must be met. The manager must so arrange his finances that he will have adequate cash to meet these expenses at the time when cash inflow has almost ceased. It is highly important therefore that he chart his expenses month by month and also alongside of them his cash inflow. He must show for each month the amount of money he will have on hand at the beginning of the month, the amount he will take in, the amount he will pay out, and his balance at the end of the month. He will show how the various expenditures will be divided—so much for raw material, so much for pay roll, so much for officers' salaries, so much for salesmen's salaries and expenses, so much for supplies and other items not entering directly into the product. If the sum of all these expenses in a given month is greater than the cash inflow plus the balance on hand, he has two courses open to him. If his credit is good he can arrange for financing at the bank. If this course is not feasible, then he must scan his expense accounts and reduce one item or another to a point where he has achieved the necessary balance.

BUDGET IS A YARDSTICK

Budgeting is simply looking facts in the face. Facts sometimes are disagreeable things, but in business it is far more disagreeable in the end to ignore the facts and substitute wishful thinking. That way lies bankruptcy. The budget gives to the general manager a picture of the business as it will go along from month to month throughout the year and enable him to lay out his course accordingly. Many managers and most accountants regard the budget as sacred, once set up, never to be changed. Regarded in this manner, the budget is anything but a helpful tool. In fact, it may become a drag on any business. The clear-thinking manager regards his budget principally as a yardstick by which to measure his performance at a given time. The budget should be flexible and subject to revision whenever conditions change.

For example, the outbreak of the war in Europe last summer changed the complexion of the entire machine-tool industry. While this industry was experiencing a slow recovery from the effects of the "unpleasantness" of the last ten years, it had by no means achieved anything like what might be called prosperity. Let us say, for example, that a given concern had forecast its sales in January at $1,000,000 for the year 1939, and its expenditures at, say, $925,000, returning a net profit at the end of the year of $75,000, which we will all admit is a very modest percentage. The demands of the war in Europe suddenly changed this picture and instead of $1,000,000 worth of sales, our hypothetical company found on its books by the first of November a total volume of sales of $2,000,000 with the tide still rising. Obviously, the original budget was so much waste paper and a new one had to be prepared. Since there was no way in October and November of forecasting what the total demand would be, or of forecasting prices of raw materials or of wage rates six months hence, it would be a foolish manager who would attempt to make a long-term budget. He would base his forecast of both income and expenditures on a much shorter period, say two to three months, and be prepared to change them almost instantly as conditions changed.

For example, careful inquiry in October indicated that there might be a rise in the price of raw materials of 10 per cent within the next quarter and that possibly wage rates might rise as much as 15 per cent within six months. The wise manager then would make provision for these increased expenditures in his short-term budget. At the same time he would be conservative as regards income and would not budget an increase in his prices until he had been forced to do so by the increased costs of manufacture. He then would be safe two ways. If the expected increases in material costs and wage rates did not materialize, his expenditures would be less than contemplated and he would not have to face the necessity of financing. On the other hand, if prices increased without corresponding increase in expenses, his profits would be greater and no financing would be necessary. If expenses increased at the same time prices did, he still would be safe because he had made provision for this contingency. No matter what happened he would not suffer disappointment.

The budget is not a pretty picture to look at and admire; it is a tool to be used, and the method of using it is to check performance against the budget figures. This usually is the duty of the chief financial officer of the company, in large organizations the comptroller, and in small ones the treasurer. Every month the financial officer should collect his costs, classified according to the budget setup. Where the costs show in excess of the budget allowances he should immediately institute investigation with the department heads concerned to ascertain why expenditures were higher than those contemplated. If the operation indicates that an error has been made in the budget setup and the excess expenditure will continue from month to month, then the budget should be revised, or steps taken so to change operations as to bring expenditures within the limit. On the other hand, if expenditures in a given classification are lower than the budget figures, it may indicate that the allowance made for a certain purpose is too great, and the budget should be revised accordingly. The practical effect of this is to release funds that have been allocated to one purpose where they are not needed for use for some other purpose where they may be necessary. For instance, the overexpenditure in one department may be counterbalanced by the underexpenditure in another without any increase in the total expenditures. Where the financial officer can make the corrections in operations simply by calling the attention of the involved department head to his departure from the program, the general manager has nothing to think about. On the other hand, if the comptroller cannot resolve the difficulty himself, the matter then is one for the general manager's attention. That is, the general manager deals only with problems which no one else can handle.

HOW THE BUDGET WORKS

Let me give a single illustration of how this application of the budget works. In a very large corporation of which I was general manager a number of years ago, our fuel bill ran in the neighborhood of $100,000 per year. The budget was set up on the basis of previous performance. After it had been in operation for about three months the comptroller called my atten-

tion to the fact that the fuel costs were increasing steadily from month to month without any corresponding increase either in kilowatthours from the power plant or increased production from the heating and melting furnaces. The purchasing agent was called in and he stated that he could not explain the difference because he was paying less per ton for his fuel than he had the previous year. The conclusion was that the mill and power plant had decreased in efficiency. A consulting fuel engineer was called in and asked to make a "horseback" survey of the fuel conditions in the plant. As a result of this survey the fuel engineer was engaged to redesign the furnaces, both for the heating and melting and also for the power plant. He wrote fuel specifications which were rigidly adhered to. The cost of the changes made, including about $2000 for the consulting engineer, ran in the neighborhood of $10,000. The net result, however, was a reduction in the fuel bill of about $20,000 per year.

The subject of budgeting is so large that it could not adequately be comprised within the time allotted for this talk. In fact we could talk for several afternoons on the subject of budgets without beginning to exhaust its possibilities. However, I have given an outline of how the budget works and I may say here and now that it is the most useful tool that the general manager has, and that any general manager who attempts to operate a company in this day of highly competitive business without a budget not only is no general manager but he shortly will not have a business to operate.

REDUCTION OF COSTS IMPORTANT TO MANAGER

At the beginning of this discussion of the budget we cited an alternative to prices higher than the market. That was the reduction of costs. The reduction of costs, not only to meet competition but also to insure greater profits, is a job that the general manager cannot neglect for one single moment. Every activity in the company must be scanned all the time to find sources of waste and methods of manufacturing at less cost. In the metal-working industries with which I am most familiar and to which most engineers naturally gravitate, there is an almost infinite variety of ways to eliminate waste and reduce costs.

Take the very simple matter of transporting material in process around the shop. It is not so very long ago that parts were lifted one by one onto a hand truck and moved to the next operation. Arrived at its destination the load on the truck was lifted piece by piece to the floor and then reloaded and unloaded between every subsequent operation. It is a well-known fact in industry that every time a man lays his hand on a piece of work it costs money. The expense of transportation of work around the shop, particularly the larger shop, has in the past been enormous. The modern method is to put the work on skids that can be picked up by a lift truck and moved to the destination without rehandling. Arrived at the machine where these parts are to be worked on, the mechanic picks them up as needed from the skid and replaces them on an empty skid alongside of the machine. When the skid is filled with finished work, the lift truck picks it up and moves it to the next operation. Every movement in the handling of the work is a useful movement and no money is wasted in useless handling.

A single example will show how much a study of internal transportation may save. In a certain company in New England employing upward of 4500 people in the manufacture of machinery—a plant which covered several city blocks—about 500 men were employed solely for the purpose of moving work through the shop. A detailed study of the transportation problem and the provision of electric lift-trucks reduced the number of men employed in more or less useless work to less than 50. And right here let me answer the question that I am sure will be raised: "Were the 450 men thus displaced, thrown into the street to become a burden on the community or as we say today, 'go on relief?'" Incidentally, this was before the days of "relief." The answer is, They were not. They were absorbed in the industry itself, the only difference being that they were put at productive work at higher wages than they were able to earn as truckmen. The saving that was made possible by the substitution of modern means of handling was so great that the company was able to increase the wages of these men put at other jobs and yet at the same time add a substantial sum to the earnings of the corporation.

PRODUCT DESIGN AND PRODUCTION METHODS DEMAND ATTENTION

The general manager is thinking all the time, in connection with his cost-reduction program, of the design of the company's product and of the methods that the shop is using in manufacturing. Is the material entering into the product the best material for its purpose? If so, can it be bought at a price that will represent the greatest economy? Is there another material that will serve the purpose just as well without any sacrifice of mechanical excellence, and yet one that will cost less? Is a given piece so designed that it must be machined in a large and complicated machine like a horizontal boring, drilling, and milling machine which carries a heavy burden rate, or can it be designed so that it can be machined in a drill press which carries a burden rate of less than half of that of the heavy horizontal? Here is a series of holes to be drilled in a certain surface. The shop is laboriously laying them out with a scale, dividers, and center punch. Is there not a simple jig that can be designed and built for a few dollars that will entirely eliminate the layout operation and which will pay for itself on the first job? How are the shop machines as regards accuracy? Are the foremen looking after their maintenance so that work, when it comes from them, does not require expensive correction and refitting? Will a special tool here enable one operation to be performed where two are now the usual practice?

Not so many years ago in all shops and still today in many shops, the questions of feeds, speeds, and depths of cut were left entirely to the judgment of the individual worker or at best to the judgment of the foreman. Back in 1903 a man named Frederick Winslow Taylor discovered that the cutting of metals was not an art, but an exact science and that there was, for each material cut, a combination of shape of tool, feed, speed, and depth of cut that would produce the largest output for a minimum of expense. Since Taylor's day many researchers have added to the fund of knowledge left by Taylor and the extent of this knowledge is so great that no workman, no foreman, can be expected to know all about it. The general manager who is onto his job is investigating the methods in use in his shop to see that the fullest advantage is being taken of this stupendous fund of knowledge and to see that the methods of cutting metal in use are such as will yield the lowest costs of production. He will set up a department that will investigate the application of the various tool steels, forms of tools, and other factors applicable to the cutting of metals, that will set up standards directly applicable to the problems of his own shop, and that will see that these standards are applied. I do not think that I am in error in stating that, in the average shop, costs of machining can be decreased 25 to 30 per cent by the application of our present knowledge of the art of cutting metals.

SALES POLICY IS IMPORTANT TO SUCCESS

Another thing that the general manager thinks long and earnestly about is sales and sales policy. One of the questions that arises in his mind aside from how much the volume of

sales will be in a given year or period is: What is the best method of selling, through agents or jobbers or by using salesmen, otherwise known as direct selling? The financial setup of the different methods is not the only factor that must be considered. Sales customs, the convenience of customers, the ability to make prompt deliveries, all have a bearing on the choice of sales methods. When the manufacturer sets up his own sales force and sells direct he has the advantage of absolutely dictating his company's sales policies and of selecting his customers. On the other hand, he has to bear the burden of sales expense which includes salesmen's salaries and commissions and traveling expenses. These expenses may be reduced greatly if he sells through jobbers or agents. However, he will have to pay more or less greater commissions, which may or may not exceed in volume the cost of his own sales organization. No set rule can be laid down as to which of the several methods of sales is the best. Each decision must be made on the merits of the case at hand. In the company with which I am connected two different products are manufactured which are best sold by two different methods. Heavy machine tools are sold by direct salesmen, and small toolroom grinders are sold through agents. Certain other products might well be handled both by agents and by direct selling, or by some other combination of sales methods.

MANAGER CANNOT OVERLOOK ADVERTISING POLICY

In close connection with sales problems is the question of advertising. Some general managers think advertising is a needless luxury and chart their course accordingly. In a well-established business with a reputation for its product built up over a period of years, the momentum of the business will in prosperous times perhaps carry the business for a considerable period. In the long run, however, the concern that drops its advertising will drop a large percentage of its sales volume. This has happened so many times that it can almost be accepted as an axiom of business. Here again is something for the general manager to think about. What kind of advertising is best for his particular business? Should it be trade-paper advertising, daily-newspaper advertising, circular letters, catalogs, fliers for envelope stuffers of one kind or another sent out with the regular mail? Radio, also, is another means of advertising, which for certain lines of business is exceedingly effective. Advertising, though a very necessary part of modern business, is a highly specialized profession, and the general manager who attempts to lay out his advertising program without professional advice is just as foolish as the general manager who attempts to design the mechanical product of his company without engineering training. So another thing the general manager thinks about is what kind of an advertising agent he shall engage, and how much he shall pay him, and how much he can afford to spend on advertising. A company can throw away a vast amount of sales by an insufficient advertising appropriation. On the other hand, it can go broke very quickly by an injudicious expenditure for publicity.

PUBLIC RELATIONS ALLIED TO ADVERTISING

Closely allied to advertising in the general manager's mind should be the subject of public relations. A manufacturing organization has several duties, some of which management is just beginning to recognize. It has a duty to its stockholders so to use their money as to provide adequate returns on the investment. It has a duty to its employees, not only to provide them with living wages or better than living wages, but to make the conditions under which they work clean, comfortable, sanitary, and as cheerful as possible. Management can have no greater asset than a contented working force, a crew that takes a pride in its job and is thoroughly convinced that it is working for the best concern in the city, and that thinks the bosses are "swell guys."

The ramifications of the duties of management to its employees have never been better illustrated than by some statistics given recently by H. W. Prentice, Jr., president of the National Association of Manufacturers. These statistics show what an industry employing 150 men means to a community. Let us say that a factory of this size is the sole manufacturing enterprise of a town. What does this represent? According to Mr. Prentice it represents a plant investment of about $100,000 and an annual pay roll of $200,000. It supports 1000 people, a dozen stores, a 10-room schoolhouse, sales and service for 200 automobiles, and it gives opportunity for the employment of a dozen professional men, doctors, dentists, lawyers, and the like. It provides yearly markets amounting to $300,000 for agricultural and farm products. It pays freight and passenger fares amounting to $60,000 annually to the railroads, and promotes an annual expenditure in trade in the local community of $1,000,000. It sets up a taxable value of the plant and the homes, stores, and shops supported by the plant of $1,000,000. An industry employing 150 men is a small industry today, yet we see that its responsibilities are great and widespread. Consider how much greater they are in an industry employing 1000, 5000, or 10,000 men.

Back of all his decisions in regard to company policy, the general manager unconsciously has to think of what that decision may mean to all who are dependent on his plant, in one way or another, for their existence. For example, consider a company that manufactures a stock article that can be sold off the shelves the day after it is manufactured or a year later. A depression hits the country; orders cease coming in. Management is immediately faced with a grave responsibility. Shall it cease manufacturing and lay off its help, thereby conserving its assets, but bringing distress to its employees and further depressing the business of the town in which it is situated, and also of those manufacturers who supply it its raw material? Or shall it go on manufacturing, piling up stock, which it knows it can sell if the depression ends within a reasonable period? The second course will deplete cash reserves but may buy an amount of good will that will be well worth the risk. It is a policy, however, that must be pursued with caution, for in a long-continued depression not only will cash reserves be depleted to the danger point, but the very nature of the depression probably will cause a shrinkage in the value of the stock piled up and thus still further decrease the tangible assets of the company.

It has been my privilege, or pain, as the case may be, to have been connected with two different companies, each of which in times of depression pursued one of these two different courses. In both cases, had the company pursued the opposite course at that particular time it would have been better off at the end of the depression. So here again is a case where no set rule can be laid down and each case must be decided on its merits. It is a difficult responsibility for the general manager in times of poor business to determine the course he shall pursue. The only safe course is to face the facts boldly, determine from his knowledge and experience which is the better course to pursue, and then, having made up his mind, proceed resolutely to follow that course.

I said that advertising was closely allied to public relations. If we follow the thoughts that have just been expressed it is easy to see how this may be so. John Jones runs the grocery store which is supported by the pay envelopes of the employees of our hypothetical industry employing 150 men. John Jones may not know it, but his fortunes are bound up inextricably with the fortunes of the manufacturer. If the manufacturer goes broke, his employees will stop buying from John Jones,

or may buy "on tick," leaving John Jones in the end with a lot of unpaid bills and uncollectible accounts. So he too goes broke. If John Jones and the manufacturer are the only business concerns in that town, John Jones and the manufacturer understand each other very well, and it is unnecessary for the manufacturer to advertise to John Jones in the daily newspaper what he is doing for him. But transfer the manufacturer to a large city like Cleveland or Pittsburgh. Increase his pay roll to 5000 or 20,000 men and perhaps build a couple of plants for him in other large cities. Then he becomes an abstract personality that John Jones cannot connect in any way, shape, or form with his business. It is here that advertising comes into play. The large corporation which advertises tells John Jones what it is doing for him and how much the prosperity of the manufacturer means to John Jones and how anything that government or labor does that prevents the manufacturer making profits reflects directly on the prosperity of John Jones. You can call to mind many cases of advertising where the whole purpose has been to improve the relations of the advertiser to the public. Two illustrations in point are the advertising of the American Telephone and Telegraph Company and the Association of American Railways.

LABOR RELATIONS—"A TOUGH MUG, BUT SQUARE"

Public relations brings us naturally to another kind of relations, which occupies one of the most prominent corners of the general manager's mind, namely, labor relations. The greatest asset that any company can have is the skill of its working people. Andrew Carnegie once said that you could destroy his capital, burn down his mills, and otherwise wreck his business, but leave his organization intact and in five years he would have fully recovered his position. The wise general manager is thinking all the time about how to conserve the skill of his trained employees. Not only is he constantly seeing to it that working conditions are right in the factory, but he is making sure that his wage scales are such that a man is a little better off in his plant than in any other plant employing the same character of help in his vicinity. I do not mean by this that any maudlin sympathy need be wasted or that the management must pry into the private lives of its help. The manager's attitude rather should be that expressed by a member of the Utica Fire Department concerning his chief, Joe Sullivan.

Sullivan was president of the International Fire Chiefs Association and, as was the custom, the annual convention was held in the chief's home city. One of the visiting firemen asked a member of the Utica Fire Department, "What kind of a chap is this fellow Sullivan that you work for?" to which the Utica fireman replied "He's a tough mug, but he's square."

"He's a tough mug." That simply meant that Sullivan knew exactly what he wanted done and insisted on having his men do it. He was a rigid disciplinarian and ran one of the most efficient departments in the United States. The two things go together. "He is square." A man turning in an exceptional job was recognized and rewarded, not necessarily by money, but by something that increased his self-respect or his standing in the eyes of his associates and family.

That Utica fireman's remark concerning his chief indicates another subject that the general manager should think about, namely, "What does the help think of the general manager?" To the average employee the general manager is the company. If the general manager is square, the employee will think that the company is square. If he is easy going, seeking to be a good fellow, then the company will be regarded as an easy mark and its efficiency as a producing organization will be low. So the general manager must have constantly in mind how his actions are going to react on the working force. If I were to choose an epitaph to be written on my tombstone, based on my work in management, I think I would rather have that fireman's remark about Joe Sullivan than any other epitaph that could be written.

What Joe Sullivan did for the morale of the Utica Fire Department can be done and should be done by the general manager of every industry in the United States. Let me emphasize once more the simple recipe for obtaining these results. Know exactly what to do. Know how it is to be done. See that your men know how. Insist on their doing it. Reward them for accomplishment, and discipline them for failure.

Rigid adherence with this program will cause labor relations to cease being a problem. Human beings, taking them by and large, respond alike to the same kind of treatment. It makes no difference whether a man belongs to a labor union or does not belong to one. He is entitled to a square deal. The fact that a man thinks it to his best interest to join a labor union should not have any bearing on his treatment by management. He should be free to join or not to join just as he pleases. If management is square in its dealings with its men there will be less incentive for them to become unionized than if it tries to exploit them or to pay lower wages than is their fair due, or to work them longer hours than is good for them, or do any one of a host of things of which management has been guilty in the past. I have said publicly many times and I repeat it here that most of the ills that have beset industry both at the hands of government and at the hands of organized labor are management's own fault. I hold no brief either for union or nonunion labor. I have dealt with both. I have found that a willingness to meet the men half way or a little more than half way has always brought a like response from the men, whether they were acting as individuals, as a committee from a group of unorganized employees, or as a shop committee accompanied by the business agent of a trade union. There is no difficulty in dealing with organized or unorganized labor so long as you are willing to be square with them.

In the case of our own company the Wagner Act and the Wage and Hour Law made no difference whatsoever in the operation of the plant or in our relations with our employees. Long before the Wage and Hour Law was passed we were already operating on a 40-hour week, and the wages paid, with one exception, were higher than the minimum wages specified in the law. This one exception was the office boy. As regards the Wagner Act, certain of the employees are unionized. It has not been necessary for them to call in the National Labor Relations Board to enforce any demands. We have met with them and have bargained collectively. As soon as they saw the spirit with which we were ready to meet them they met us in the same spirit. Mutual concessions were made by both sides and our relations with the union men have been no different than with the nonunion men. I lay it all to the fact that our management is square.

THE REAL JOB IS TO MAKE PROFITS

The foregoing are just a few of the problems that come across the general manager's desk every day. There are many minor problems such as the adjustment of differences of opinion between department heads, decisions as to whether this or that policy is the best in a given case, whether or not the time is opportune to redesign the line or to design new products, listening to appeals from disciplinary action on the part of a supervisor down the line, and such other things as go to make up the day's work. But all these things are related one way or another to the real point of the general manager's job, as was pointed out previously, namely, how to make profits and to make more profits to the end that everybody shall benefit thereby, stockholder, management, employees, and the public.

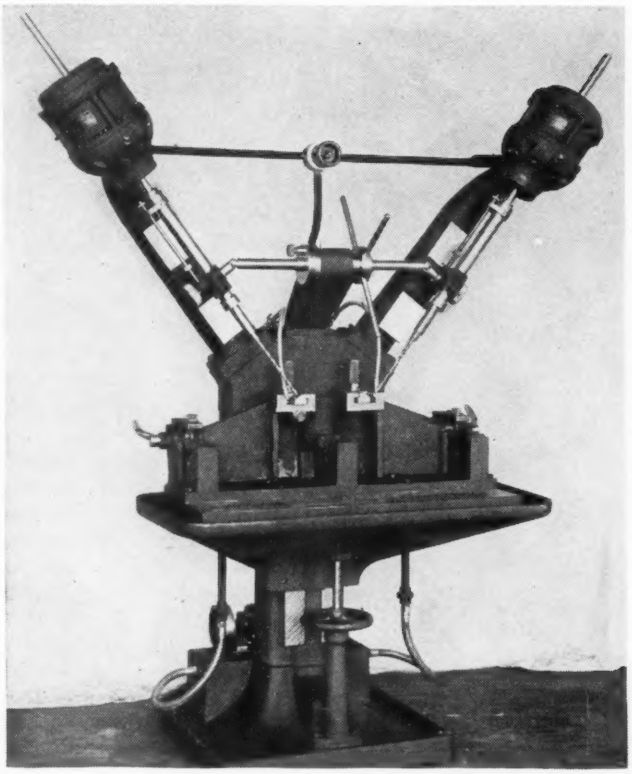


FIG. 1 MANUALLY OPERATED MACHINE FOR STEP DRILLING OIL HOLES IN AN AUTOMOBILE CRANKSHAFT

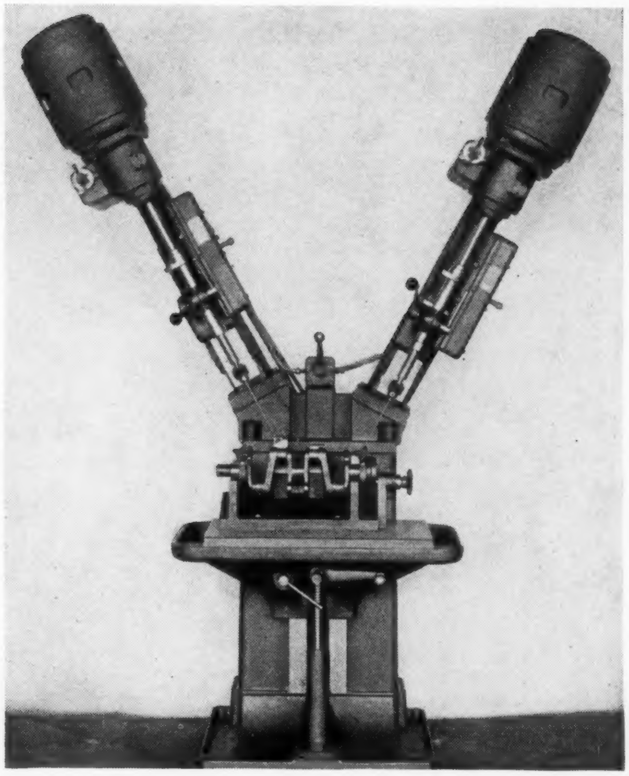


FIG. 2 AUTOMATIC MACHINE FOR STEP DRILLING OIL HOLES IN AN AUTOMOBILE CRANKSHAFT

AUTOMATIC STEP DRILLING *of* DEEP HOLES

By ERIC HIRVONEN

LELAND-GIFFORD COMPANY, WORCESTER, MASS.

THE automatic step-drilling method is especially adapted for drilling holes in parts that cannot be rotated around the axis of the hole, such as oil holes in crankshafts where the drill has to be removed from the hole to free it from chips. The drill is suitably rotated and reciprocated by the mechanism of the machine. The cycle of drilling a hole consists of fast approach toward the work, a cut into the work at the proper feed rate, a rapid return out of the hole to clear the drill and hole of chips, and a rapid advance of the drill to the bottom of the hole for another cut. This series of progressively longer advances and retractions continues until the hole is the desired depth when the drill is retracted to the starting position and the controls are automatically reset for the next cycle.

Formerly, all drilling of this type was performed on a manually operated machine such as the one shown in Fig. 1. The hard manual labor connected with the operation of a machine of this type led to the development of the automatic step-drilling machine. Fig. 2 shows a machine with two angular spindles and simultaneous starting valve for the hydraulic step-drill mechanism. One operator can handle several of these automatic machines as they run without any attention except changing the work and initiation of the cycle.

Contributed by the Machine Shop Practice Division for presentation at the Spring Meeting, Worcester, Mass., May 1–3, 1940, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

FEED RATE AND TYPE OF DRILL USED

The unit shown in Fig. 3 is adapted to be mounted on the frame of standard drilling machine. The drill spindle is adjustably connected to a slide operated by a hydraulic cylinder and piston. The cutting feed rate is adjustable from 0 to 20 in. per min. The fast-traverse movements are at a rate of 1 fps or 720 in. per min. The length of the steps can be varied from a minimum of $^1/_8$ in. to any desired distance. Gaps, or openings in work through which the hole to be step drilled passes, can be fast-traversed to eliminate loss of time. The maximum depth of hole can be adjusted to any distance within the capacity of the unit. A diagram of the hydraulic step-drilling mechanism is shown in Fig. 4.

A two-grooved twist drill is used for step drilling. A regular

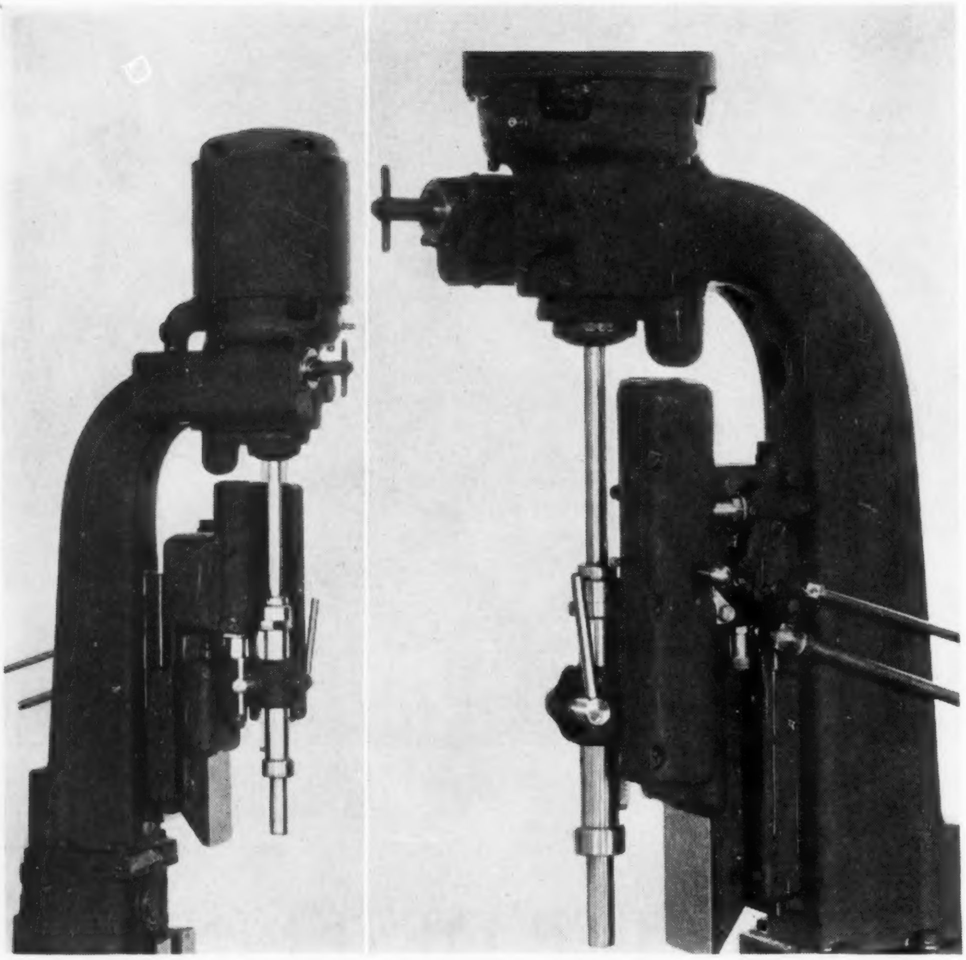


FIG. 3 TWO VIEWS OF STEP-DRILLING UNIT MOUNTED ON THE FRAME OF A STANDARD DRILLING MACHINE

stock drill will be entirely satisfactory, however, if the hole is not deeper than can be reached with the drill. For deeper holes, drills longer than stock length, but fluted only part of the length to maintain maximum stiffness, are used. The flutes should be polished to facilitate free cutting. The unfluted portion of the shank should be slightly smaller in diameter than the cutting part to prevent trapping of the coolant in the hole at the entrance of the drill into the hole. Thick-web drills, such as had to be used on manually operated deep-hole drilling machines to prevent breakage of drills, are not required for most of the automatic step drilling. The grinding of the drill point should preferably be done on a twist-drill grinder, to insure equal cutting lips with correct angles and clearance. Long straight chips should be avoided by changing the grinding of the point. A curly chip is much easier to dispose of than a straight one. The web at the drill point should be ground thin to reduce thrust on long drills.

COOLING THE DRILL

Proper and ample supply of cooling fluid is an important contribution to economical deep-hole drilling. The nonrotating work makes possible a simple and effective application of coolant. The flow must be across the hole around the drill to wash away all chips and cool the drill during its retraction. To prevent chips from being washed back into the hole, the flow must not be fast or directed into the hole. A gentle flow of coolant, in sufficient quantity, will fill the drilled hole, thus absorbing heat from the workpiece. Outside surfaces of the work should be cooled by a fluid flow, either by the overflow from the drill cooling stream, or by separate openings, distributed around the piece. This is especially important for pieces with light sections around the hole. Water and soluble-oil mixtures are suitable for steel drilling. Cast iron and other materials that have powdery chips which will form paste with cooling liquid can be cooled by an air stream. Flow of the air stream should be applied the same as the liquid, around the drill at retraction, and on the outer surfaces of the work. There is no trouble in getting chips out of the hole, even when the drill spindle is vertical, or nearly so. All step-by-step drilling with a liquid coolant should be done at some angle above the horizontal in order to get the coolant into the hole at the retraction of the drill. Drilling without liquid cooling may be done at any angle, but on vertical work the chips must be blown or sucked away on retraction of the drill to prevent them from falling back into the hole. A steel chip at the drill point on the bottom of the hole will spin with the drill and prevent cutting entirely.

LENGTH OF DRILLING STEP

The distance a drill may be fed into the work, which is the length of drilling step, depends mainly on the material being cut but also on the coolant for the drill and work. Shorter steps permit better cooling and consequent higher rate of feed and penetration, although, even without outside cooling medium, short steps mean much cooler drilling, because the shorter the step, the less heat is absorbed by the drill and work.

For example, if the step is doubled in length, the time is also doubled, the quantity of chips from the original length of step will be in the hole twice as long as in the shorter step, and the time and quantity of chips of the second half are the same as in the shorter step.

Experience has shown that best results are obtained by having the depth of each step approximately equal to the diameter of the drill up to $1/4$ in. when drilling steel with ample supply of coolant. Maximum penetration with drills larger than $1/4$ in. can be obtained by increasing the depth of steps by, perhaps, one quarter of the drill diameter above and over the initial $1/4$-in. depth. Thus, a $1/2$-in. drill may have steps of $1/4 + (1/4 \times 1/2) = 3/8$ in., and a 1-in. drill $1/4 + (1/4 \times 1) = 1/2$ in. This rule holds regardless of the degree of hardness of the steel as the cutting speed and feed per revolution are set to secure the most economical time between sharpenings of the drill. Therefore, approximately the same amount of heat will be generated in a given distance whether the steel is hard or soft. The time is shorter for the soft material. Longer steps can be used with slower feed rate than the maximum permissible for the material to be drilled. Hence, longer steps than those already mentioned are permissible for deeper holes where the feed is limited by the slenderness of the drill. Iron, aluminum, and other castings that do not form long chips may be drilled in considerably longer steps than the aforementioned materials.

Materials that are hardened by cold work, such as some of the stainless steels, can be drilled with a rigid drilling machine where the deflection between the drill point and work has been brought to minimum. This is to insure a quick bite into the work and equally quick letoff, to prevent any "ironing" and consequent work hardening.

Attempts to control the length of the step by increase in torque or thrust have not been successful. There is practically no regular increase in either thrust or torque until the drill has been dulled to cause such an increase. Continuation of the drilling would then be impossible without resharpening, as the drill would be retracted as soon as it started cutting. The increase in torque from chips clogging the drill flutes is indefinite and variable. The steps resulting from torque control will be quite irregular in length. Both feed and speed of the drill will have to be greatly reduced to keep the drill cool enough to have a reasonable life between sharpenings. Therefore, maximum production can be obtained by keeping the steps relatively short and regular in length. Another reason for the regular step is that the straightness of the hole is adversely affected if chips bind in the flutes of the drill.

RATE OF FEED AND CUTTING SPEED

The most productive rate of feed can be determined by trial in each case, as it varies with material, length of step, diameter, and length of drill and coolant. Sound produced by the cut is the best indication of the most economical feed. When feed is increased the torsional vibration increases and, beyond a certain point, rapid dulling of the drill takes place. A small amount

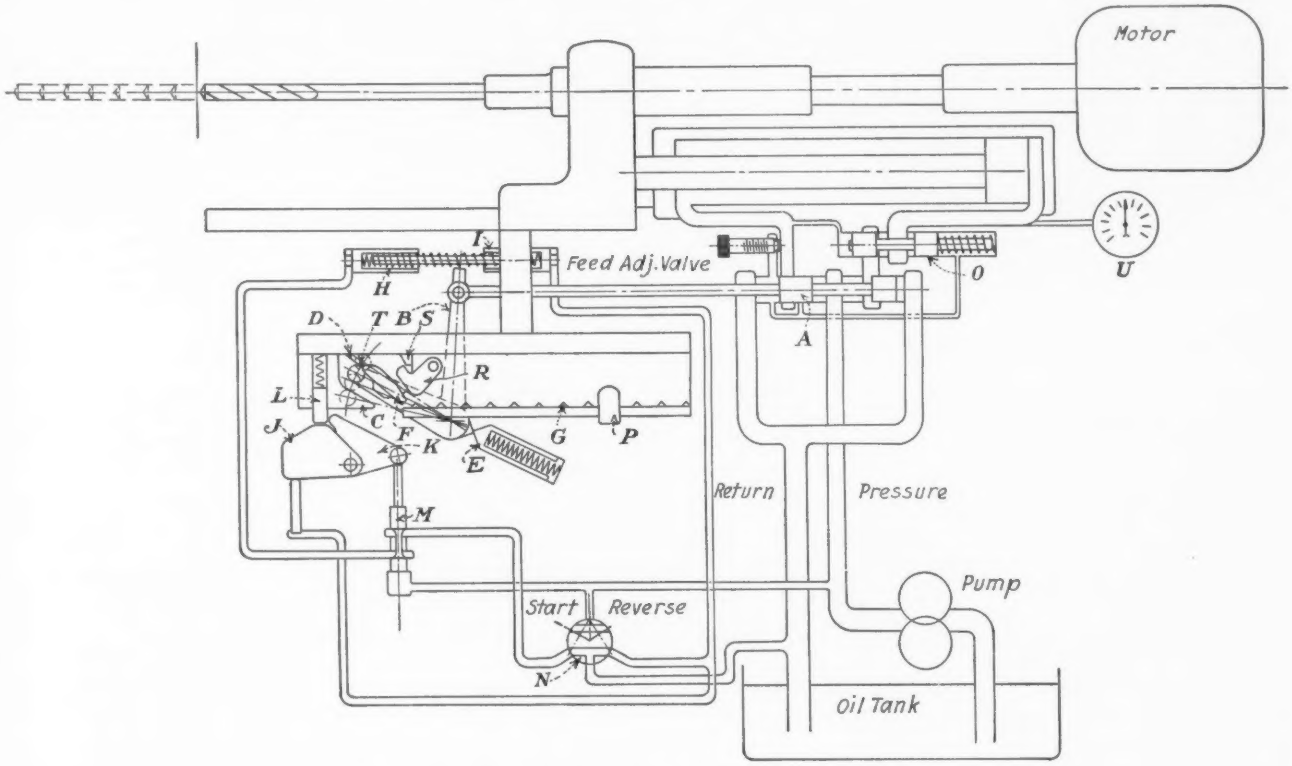


FIG. 4 DIAGRAM OF HYDRAULIC STEP-DRILLING MECHANISM

(Valve *A* controls all movements of the drill. It is operated through bell crank *B* by cams *C* and *D* on a bar connected to the main drill slide. Spring plunger *E* tends to throw the valve *A* to either of the extreme positions which are the fast approach and fast reverse. Cam *D* brings the valve to the adjustable feed position and wedge *F* throws the bell crank over the point of the spring plunger to fast reverse. Length of drilling step is controlled by the spacing of pins *G* which make contact with the rocking wedge *F*. Cam *D* moves on the bar with the feed; thus lengthening the fast approach and return strokes. Rocking movement of wedge *F* permits it to pass under the pin *G* that reversed the unit at the preceding step; but pin *T* on the bell crank moves it again to the interference position with the next pin. Plunger *L* through lever *K* and valve *M* starts the unit after withdrawal. Adjustable stop *P* controls the final depth of the hole by depressing latch *R* to cause resetting of cam *D* at the final retraction. Cam *C* holds the unit at the retracted position. Manually operated remote-control valve *N* is used to start the cycle through plunger *H*. Plunger *I* reverses the drill if interruption of the drilling cycle is required; latch *J* pushes plunger *L* to bring the unit to stop at the fully retracted position. Valve *O* is an automatic throttle to keep constant back pressure on the piston and vary the pressure on the forward side according to the demand of drill thrust. Gage *U* shows the pressure required to feed the drill.)

of torsional vibration seems to help the cutting and more pieces per sharpening can be obtained that way. The length of step and feed rate are also interrelated. The longer the step, the slower the feed. Balance between feed rate, length of step, and drill speed depends on many variables, such as material of the work, type, diameter, and length of drill, and amount and quality of the coolant.

Cutting speed may be determined the usual way for the material to be drilled and generally should be as high as possible without causing too much wear at the corners of the drill. Lack of stiffness of drill and shank limits the depth of hole that can be economically drilled to no more than fifty times the diameter of drill for holes over $^5/_{32}$ in. diameter. On smaller sizes, the maximum depth is less than fifty times the diameter and depends greatly on material being drilled. There is difficulty with the chips when small holes are drilled in some tough and stringy materials. Frequently, heat-treatment of the work to be drilled to a slightly higher Brinell makes the drilling much easier and free from drill breakage and trouble.

Cutting time lost during the drill retractions further limits the maximum depth on larger sizes of holes to a maximum of 2 ft, or thereabouts, except when drills with oil holes are used, which permit longer steps and consequent increase in the ratio of cutting time to idle time.

The usual rate of rapid traverse of the step-by-step drilling mechanism is 1 fps, or 720 in. per min. For example, drilling a hole $6^1/_4$ in. deep in $^1/_4$-in. steps at a cutting rate of 4 sec per step, a total of 100 sec is used for drilling and about $12^1/_2$ sec for the fast approach and return strokes. This is a ratio of 8 to 1 cutting to idle time.

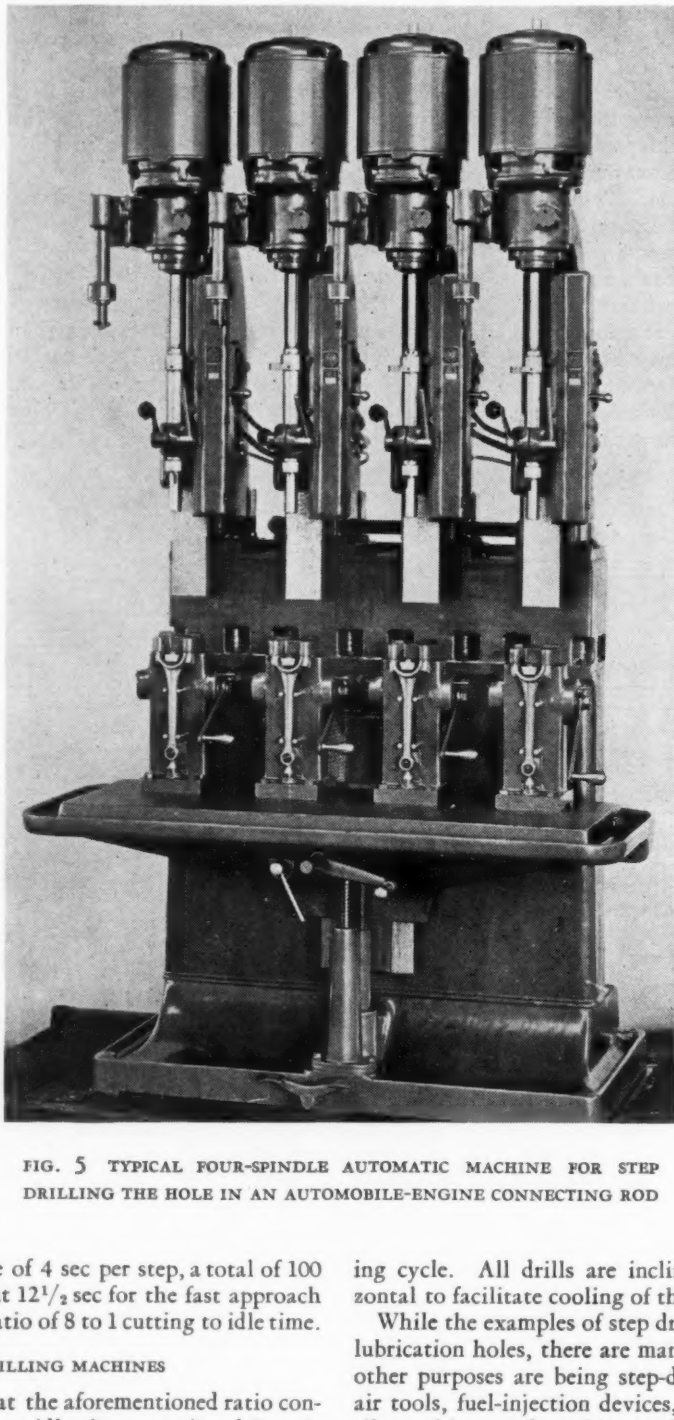


FIG. 5 TYPICAL FOUR-SPINDLE AUTOMATIC MACHINE FOR STEP DRILLING THE HOLE IN AN AUTOMOBILE-ENGINE CONNECTING ROD

TYPICAL STEP-DRILLING MACHINES

Drilling a hole 25 in. deep at the aforementioned ratio consumes 400 sec cutting and 200 sec idle time, a ratio of 2 to 1, that is, 50 per cent of the time is used for fast traverses in drilling a hole 25 in. deep, against only $12^1/_2$ per cent in drilling a hole $6^1/_4$-in. deep at the same cutting rate. Of course, this is a purely imaginary case to illustrate the relation between cutting time and idle time. Ordinarily, a hole 25 in. deep would have to be $^1/_2$ in. diameter to be economically drilled by the step method. A hole $^1/_2$ in. diameter may be drilled with steps $^1/_2$ in. long, especially when the drill is long and the feed rate is necessarily low. The ratio then becomes 400 sec cutting to 100 sec traverse time, or 4 to 1. Holes more than 30 in. deep are being successfully drilled with an oil-hole drill.

Fig. 5 shows a typical four-spindle machine for drilling the oil hole in an automobile connecting rod. The quick-acting jig shown permits one operator to handle 150 or more pieces per hour. This number of pieces usually requires from six to ten spindles, depending on the length of the hole and drilling qualities of the material of the rod. This type of machine and jigs are also used for larger connecting rods, such as those on Diesel engines and refrigerating machines, as well as cam shafts and similar parts.

Fig. 6 shows a crankshaft line in an automobile factory. The machines are of the two-spindle angular type similar to those of Fig. 1. The shaft is drilled, a pair of holes at a time, by progressively passing it from one machine to another along the line.

A six-spindle machine for drilling all oil holes at one setting in a crankshaft of a six-cylinder engine is shown in Figs. 7 and 8. The hydraulic clamps for the shaft are worked by one of the two manually operated valves on top of the jig. The other valve is for the simultaneous starting of all the drilling units for the drilling cycle. All drills are inclined at angles above the horizontal to facilitate cooling of the hole.

While the examples of step drilling shown here are for oil or lubrication holes, there are many applications where holes for other purposes are being step-drilled. This includes holes in air tools, fuel-injection devices, carburetors, instruments, textile machines, and machine-tool parts and spindles.

Machine designers should investigate the economy of drilling by the step method. Often, designs can be simplified and appearance improved by providing drilled internal passages.

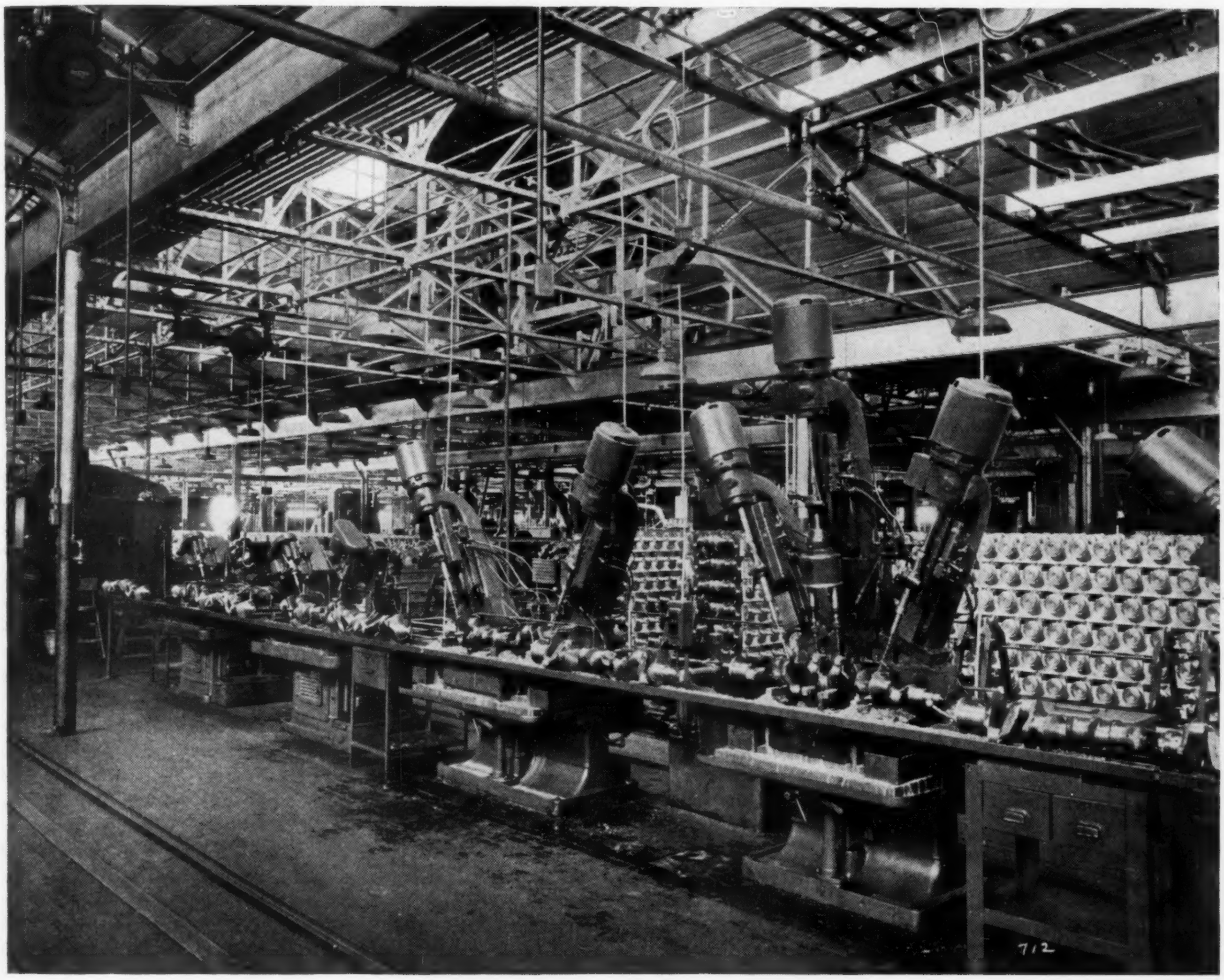


FIG. 6 CRANKSHAFT LINE IN AN AUTOMOBILE FACTORY

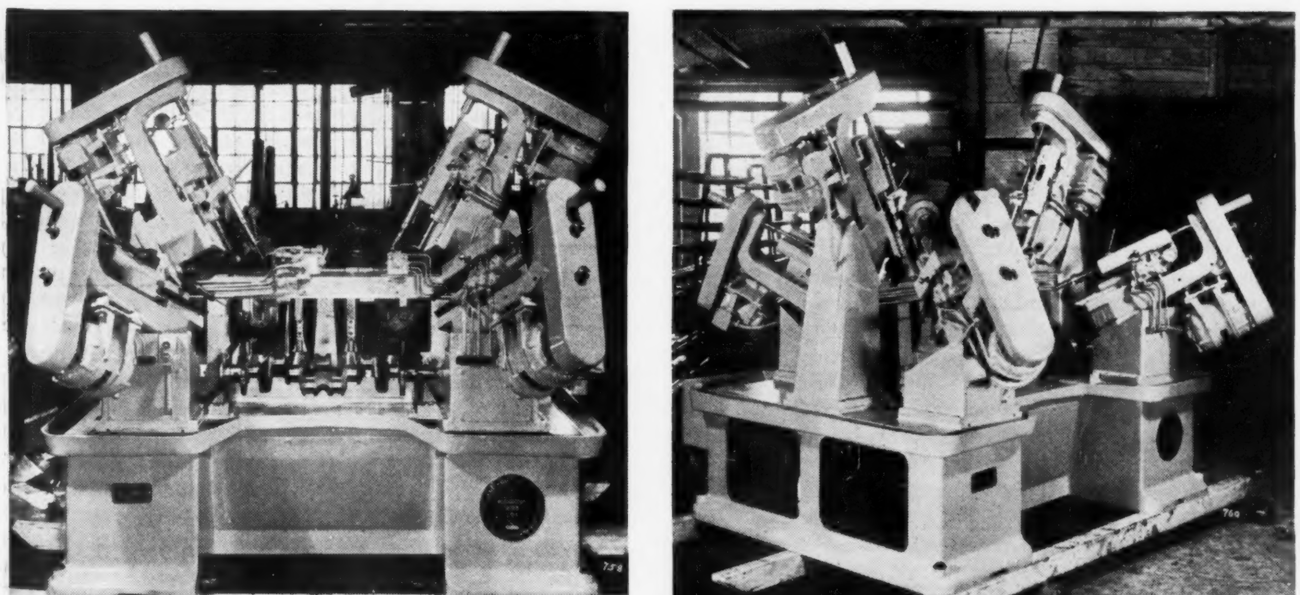


FIG. 7 SIX-SPINDLE MACHINE FOR DRILLING AT ONE SETTING ALL OIL HOLES IN THE CRANKSHAFT OF A SIX-CYLINDER ENGINE

TOWARD A "CONTROL" SYSTEM FOR INDUSTRIAL RELATIONS[1]

By CONRAD M. ARENSBERG

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

WITH the publication of "Management and the Worker," by F. J. Roethlisberger and William J. Dickson,[2] the story of the now famous Hawthorne experiments of the Western Electric Company is complete. Now that the story is all in, it is instructive to take stock of the position to which the experiments have advanced the theory and practice of industrial relations and to ask what the next step is to be. If there is to be a next step, the authors and researchers of the studies reported in "Management and the Worker" can count it as their reward for a long labor well done.

The book itself puts the challenge—what next? The authors could hardly have chosen a better title for it. It is in itself a manual of nearly all the scientifically verified knowledge on its subject that exists in the year 1940. The book is the comprehensive report of the long-term research into human relations, morale, and efficiency in the workroom carried on by the company over the years from 1927 to 1938. Much of the research is already well known and has been reported before in various places. Still, in total, it stands as a rare combination of detached scientific inquiry and hardheaded, practical search for a workable program. "Management and the Worker" has the great merit of pulling the whole story together and showing the successive stages of development through which the researchers progressed in the interpretation of their often unexpected results. But it also presents in detail much important work not reported in full before, and welds the theoretical and practical knowledge finally gained from the research into an organized operating procedure for passing information up the line to management. It is an honest, painstaking story, in the best tradition of research.

WHERE DOES HAWTHORNE RESEARCH LEAD?

Now that this story is complete, let us take a look at it. There is more than enough in it to serve as a guide for the executive of management, the engineer and expert technician, and the student of industrial psychology and organization. The book sums up the results obtained from the studies made, in the relay-assembly rooms, on the effects of such controllable factors as illumination, rest periods, hours of work, and wage incentives, upon individual output, efficiency, and morale. This is the material already given in great detail in the work of T. N. Whitehead, entitled "The Industrial Worker" and reviewed in the December, 1938, issue of MECHANICAL ENGINEERING. It is instructive to see it here in the perspective of the whole research and to follow the further inquiry to which it leads.

It is this further inquiry, dealing directly with the implications of the study of physical factors controlling employee output and morale, to which managers, engineers, personnel men, and students of industrial psychology and organization can most fruitfully turn their attention. It will be remembered that the result of the study of the effects of physical factors was to demonstrate the impossibility of appraising them with any certainty unless social and psychological factors were taken into account. Through statistical and correlative techniques, output records were shown to reveal, not so much the influence of changes in the controllable factors in the experiments, as the effect of change in social relations and social attitudes among the personnel of the working groups. The significant factors correlated with increased output turned out to be, not the experimentally varied ones subject to the direct control of management and technicians, but the more intangible ones beyond immediate experimental control. These were the influences springing out of the often unconscious, informal habits and adjustments made by the employees in their relations among themselves and with their supervisors in the workroom. The remarkable correlations of output and social relations among the five girls of the relay-assembly room, later further exemplified in other test groups, raised theoretical and practical problems needing immediate solution. Whatever the connection of cause and effect between better physical working conditions, incentive schemes, shorter hours of work, rest pauses, and other measures combating fatigue and monotony, on the one hand, and increased output and morale on the other, it expressed itself only in correlation with satisfactory "human relations." The evidence was that these "human relations," if they were to be anything at all, were to be found in the conditions of mutual adjustment among the members of the working group. The next problem of research, therefore, was to isolate, describe, and interpret for practical use the social situation in which the workers moved and upon which changes in physical factors impinged.

WHAT DO PERSONAL INTERVIEWS REVEAL?

Another part of the Hawthorne researches bore out this conclusion. "Management and the Worker" reports in full the experience of the company in interviewing some 20,000 of its employees and a large number of its supervisors of varying ranks. Made back in 1928, this was one of the first large-scale attempts at sounding out employee attitudes. It yielded many interesting results, many of which have already become matters of fairly common knowledge. But the most interesting result was probably a better understanding of what interviewing reveals and how to interpret the attitudes interviewing turns up.

Like the experimental studies, the interviews revealed the necessity of having a means of dealing with the social situation. They indicated that employee attitudes must be understood in terms of the context in which the employee thinks, which is in turn the "human" situation in which he acts, in his relations, that is, with his fellows in the workroom, his immediate supervisors, his actual associates at work and outside of it. What a man says to an interviewer, once his confidence is won, cannot, ordinarily, be treated, to any useful purpose, as a reasoned conclusion or a factual report. What he tells is an expression of his present experience of the concrete events of the day-to-day

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

[2] "Management and the Worker," by F. J. Roethlisberger and William J. Dickson, Harvard University Press, 1939.

relations between himself and his group of fellow workers and his immediate supervisors in the workroom.

What he gives the interviewer is a reflection of his own and his fellows' sentiments, fears, preoccupations, and past experience. In many instances, the lesson of interviewing in psychology was borne out in the attitudes got from employees. Complaints, grievances, comments, and suggestions, made in the interviews, referred not so much to their ostensible object as to some preoccupation arising out of personal emotional disturbance. The source of this disturbance might be either in the work situation or outside the relationships of life in the company altogether. But in either case, it operated to color the employee's understanding and reception of company procedures, policies, and personnel, and to affect the employee's output and morale, on a directly personal basis. In many cases the experience of clinical interviewing seemed to be borne out; the mere process of interviewing, "getting it off one's chest," seemed to help an individual to make an adjustment. In others a knowledge of how matters fitted specifically into the sentiments and experience of the individual could be used to effect beneficial changes. But in all cases the source of the individual's attitudes was to be found in his personal situation at work and outside it. In so far as his personal situation referred to his work, it could only be described by reference to the actual conditions of mutual adjustment between the individual and his fellow workers and immediate supervisors in the workroom.

To get at the source of worker attitudes, therefore, presented the same problem as did the search for the effects of experimentally controllable factors on output and morale. There must be some objective method for discovering, describing, and keeping a check on the social situation in which the workers move on the job.

STUDYING HUMAN RELATIONS "ON THE JOB"

The last part of the book tells us how this problem was tackled. It reports a detailed study of a shop, the bank-wiring room, with the express purpose of dealing squarely with "human relations" on the job and reducing them to an orderly process of observation, description, and analysis of results. Ordinarily, engineers and others with a background in the natural sciences have been leery of the realm of social relations. There seems to be nothing concrete to record and measure, and nothing objectively ascertainable with which to deal. The social sciences have not been of much help, for they deal either with large-scale statistical trends, or they are still wrestling with the preliminary problems of definition and classification. Furthermore there is no common set of conventions or common vocabulary of terms for describing, counting, and correlating what takes place in "human situations" comparable to those the long history of science has built up in, let us say, the physical or chemical fields.

The lack of these things was not allowed to hold up the researchers in their attack on their problem of the effect of "employee interrelations and group organization" on the job. Part of an ordinary shop department was segregated as an experimental situation and an observer placed in it. Otherwise there was no change made. The observer was to interfere with nothing and to exercise no authority of any kind. He was only to observe what took place among the persons in the room. Except for that, the ordinary current of departmental work carried on. The departmental group payment system continued unchanged; the usual output and efficiency records were kept.

But a continuous record of all individual activity of every kind was kept: Conversation, horseplay, mutual aid, infringement of company rules, contacts with supervisors, and anything else in the way of activity in which one of the group affected another, was put down in orderly, chronological fashion just as it occurred, without reference to any standard of right or efficient conduct, merely as a description of what actually takes place in a working day in a work situation. These data were arranged according to the roles of the individual workers in them and according to the general kinds of worker reactions and worker notions they seemed to present.

This kind of orderly recording of what actually takes place among human beings in their informal and unguarded moments was, in fact, an adaptation of methods of "field work" in the branches of social science, like social anthropology, experimental social psychology, and sociometry, which are closest in spirit to the methods of natural science and have so far turned up the most interesting results. It is not surprising therefore that this painstaking observation turned up a wealth of information, which, if not altogether new, especially to those who have taken part in the work-a-day life of industry, nevertheless forced a complete re-examination of a great many of the cherished concepts of management in the field of industrial relations.

IMPORTANCE OF FIRST-LINE SUPERVISION

This observation laid bare the processes by which, by means of an informal organization and control of one another of their own, the working group restricted output to a figure they felt safeguarded them against rate-cutting or rerating, resisted the impact of technical changes in the job itself upon their established ways of behaving, and forced compromises between their own habits and convenience and the rules and policies of supervision and management. It must be remembered that all these processes were at work in a situation in which output and morale were high, a good day's job was done, though it might not equal the fondest hopes of the expert concocters of theoretical wage-incentive schemes, and as full acceptance of management rules and policies in the workroom was present as can ever be obtained. The chief problem of first-line supervision was well illustrated in this study. To be effective, supervision had to compromise at some point between the policies of management and the demands of the working group among whom those policies were to be enforced. The informal organization the study revealed, thus in fact, included the relations between workers and supervisors, and the most effective supervision seemed to be that which reconciled the policies of management with the habits of mutual adaptation among the workers.

Conversely, the evidence seemed to be that the supervision which failed to effect such a compromise was a source of antagonism, lowered morale, and increased inefficiency, even though it might be logically acting in what, on the basis of management and engineering logic, ought to be the best way of meeting management's needs for greater output, a greater personal efficiency from the men, and a more willing cooperation in line with their own self-interest. For the study illustrated several truisms of sociological and psychological investigation and showed their great relevance to the practical working problems of industry. People at work in industry act as of the social groups to which they belong and as of their status in them. The logical concepts of management are not necessarily those of the workers, and programs for action, like incentive and efficiency schemes, are never wholly acceptable by those who must work them unless they fit also into the often seemingly illogical sentiments and ruling notions which govern action in the working environment among fellow workers.

Particularly interesting for the engineer working in industry is the evidence, corollary to this, which the bank-wiring room turned up about the effect of the engineer's work. An engineer engaged in making a technological improvement on a work process or introducing a more efficient means of production usually thinks of his work as being directed entirely toward the job, and not toward the workers themselves. But (apart from

any question of replacement of men by machines) the bank-wiring-room story shows that this view is not an altogether true one. The evidence makes the "human element" a pretty tangible thing. The work of the engineer, even if by his own logics it should deal only with the "job," in fact has a direct effect upon the habits of mutual adjustment among the working group and thus, whether the engineer wills it or not, sets up a chain of changes in the activity of the workers toward one another and toward their supervisors. And these changes, if they are followed out, result in very concrete reactions of resistance, compensation for disturbance of routines, and mental readjustment of attitudes among the workers as they are informally organized among themselves in the workroom. "Selling the worker on the change" may well be possible, but only if it is fully known that the change will have such effects, and the effects are allowed to work themselves out without too great interference.

This realization is not altogether new, but it is often forgotten and its implications neglected. In a time when technical advance is the order of the day, and the social situation of the worker at his work is undergoing constant interference with each such advance, much can be done to recognize and assist the inevitable readjustments that must take place, without which no satisfactory working environment can build up among those on the job.

Thus the re-examination of many of the notions of management and technologists about incentives, efficiency, and morale in the work group, to which the bank-wiring-room study led, poses some highly practical questions. It has been said in criticism of the findings that a mere warning that changes of industrial process and management policy have a disturbing effect upon the routines of worker adjustments is of little value. The essence of industrial advance is change and further change. To put it in hard-boiled fashion, one cannot refrain from seeking to install better methods merely because it shakes up old habits. What can be done in such an event?

FUNCTION OF PERSONNEL COUNSELORS

The final section of "Management and the Worker" describes a step in the direction of answering that question and points the way for future development. In that section the authors describe a program of "personnel counseling" now in effect in every department of the company. Trained observers and interviewers, developed out of the working personnel of the company, are placed in each department. They are charged with keeping a running inventory of the social situation in their territories, lending a sympathetic ear to every person who wishes to be "interviewed," and interpreting what they see take place among the working group from day to day and what they are told by those who come to them in terms understandable to supervisors and management. These counselors are under seal of secrecy as to the identity of persons, but otherwise they function to pass information up the line about the informal constitution of the working groups they are in contact with, to point out the way in which management policies fit into the actual thinking of the workers, and to advise on the effect of changes upon the habits and adjustments of the workers. They are thus permanent investigators, counselors, confidants, and advisers, passing up information for the guidance of line officers in their dealings with the so-called "human element."

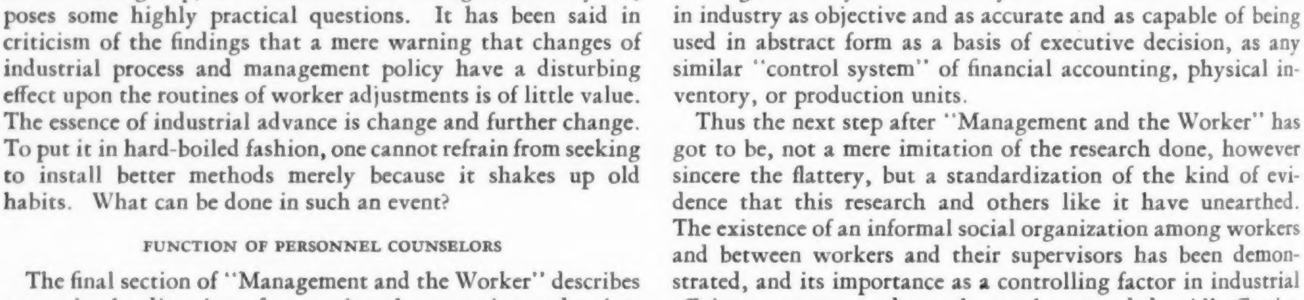
In effect then, this program, putting to practical use the theoretical knowledge got from the years of research in the Western Electric Company, may conceivably be the first step in a possible new development that can combine science and practice in an entirely new field. It is too early to see the full outline of such a development, but it will come. Many persons, learning of the experience summarized in "Management and the Worker," have objected that the findings are of no value outside the Western Electric Company itself, because the conditions of the industry are peculiar to itself, and other industries and other concerns have entirely different situations. To make the results useful to these others would require research as long and as costly of time, men, and money as that made at Hawthorne.

A CONTROL SYSTEM FOR HUMAN RELATIONS

But surely this is a mistaken criticism. For the chief result of the research is not that such and such conditions turned out to be present at Hawthorne. What the researchers actually found is far less important than the manner in which they found it. They give us the beginning of a procedure for a continuous running inventory or "control system" for "human relations" in industry as objective and as accurate and as capable of being used in abstract form as a basis of executive decision, as any similar "control system" of financial accounting, physical inventory, or production units.

Thus the next step after "Management and the Worker" has got to be, not a mere imitation of the research done, however sincere the flattery, but a standardization of the kind of evidence that this research and others like it have unearthed. The existence of an informal social organization among workers and between workers and their supervisors has been demonstrated, and its importance as a controlling factor in industrial efficiency, output, and morale can be conceded. All effective industrial-relations and personnel programs depend upon communication of information about it up the line.

Most executive "judgment" is based on an intuitive appraisal of it and, to be "good judgment," must take it into account. But without a standardization of this information so as to make it comparable for all departments, all situations, and all businesses and industries, no quick, accurate, and abstract method of inventory will be possible. The next step, therefore, is a uniform system of measurement from which indexes can be constructed and critical points be recognized. The engineer, the man skilled as a diagnostician of workers' social situations, and the executive will be on common ground, when this next step in the direction of a "control system" for industrial relations is successfully taken.



Milwaukee Journal Photo

AERIAL VIEW OF MILWAUKEE, WIS., WHERE A.S.M.E. SEMI-ANNUAL MEETING, WILL BE HELD JUNE 17–20. SEE PAGES 418–419

POWER *and* VELOCITY *Developed in* MANUAL WORK

By C. A. KOEPKE and L. S. WHITSON

INSTITUTE OF TECHNOLOGY, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

IN AN ATTEMPT to learn more about the factors affecting the performance of all manual operations, studies of the maximum velocity of certain common hand motions and the maximum power developed in them have been carried on in the industrial-engineering laboratory of the University of Minnesota. It is believed that, through such studies of elemental motions, relationships can be found which could not be discovered through the study of more complex manual operations involving a large number of uncontrolled variables. Through studies of simple motions, it is anticipated that a method may be developed by which the power expended in actual factory operations, and the fatigue-producing effects of such operations, may be determined.

The power expended by the human mechanism is a measure of the rate at which energy can be applied to a particular task. Thus, the maximum power attainable by persons having different physical characteristics is believed to be related to their capacities for various types of manual work. If definite relationships could be discovered between physical build and the maximum power developed by the individual, they might be useful in the employment office in selecting workers for particular jobs.

Of primary concern to the methods engineer is the effective application of human energy to the performance of useful work. His goal is not merely the reduction of the time required for an operation, but the attainment of maximum output *for the amount of energy expended*. It should be emphasized that the object of such studies of factory operations is not to find means of making employees work faster or increase their expenditure of energy. Rather it is to enable them to produce more with a given amount of physical effort and to assure their having a reserve of energy available at the end of the day to permit full enjoyment of their leisure time. Information on the types of motions permitting the greatest velocity and horsepower is valuable in developing production methods which increase output and decrease fatigue. Such data can be applied in the design of tools, jigs, and production machines for ease of operation, and in the placement of tools and materials at the work station to permit the most effective motions in handling them.

Six men in good physical condition and representing a variety of physical builds were selected to serve as subjects for the studies conducted at the University of Minnesota. All were between the ages of 21 and 30. Determinations were made of the maximum velocity attained and power expended by each of the subjects in accelerating weights of 6, 9, 12, 15, 18, and 21 lb. The right-hand motions made by each subject with each weight are as follows:

1 *Long forehand sweep* from right to left with the arm extended.

2 *Long backhand sweep* from left to right with the arm extended.

3 *Short forehand sweep* from right to left with the forearm only, the elbow being held at the side.

4 *Short backhand sweep* from left to right with the forearm only, the elbow being held at the side.

5 *Forward thrust* of the right arm from a position at the side of the body.

6 *Pull* of the right arm toward the body from an extended position in front of the body.

METHOD OF MEASUREMENT

While making the test motions, the subject was seated comfortably in front of a table on which the weight rested in its initial position. The starting point of each motion is shown in Fig. 1. For the first four motions, the subjects were seated directly in front of and facing the table; for the last two, they were seated near the end of the table and facing sideways. There were no definite points for the termination of the motions

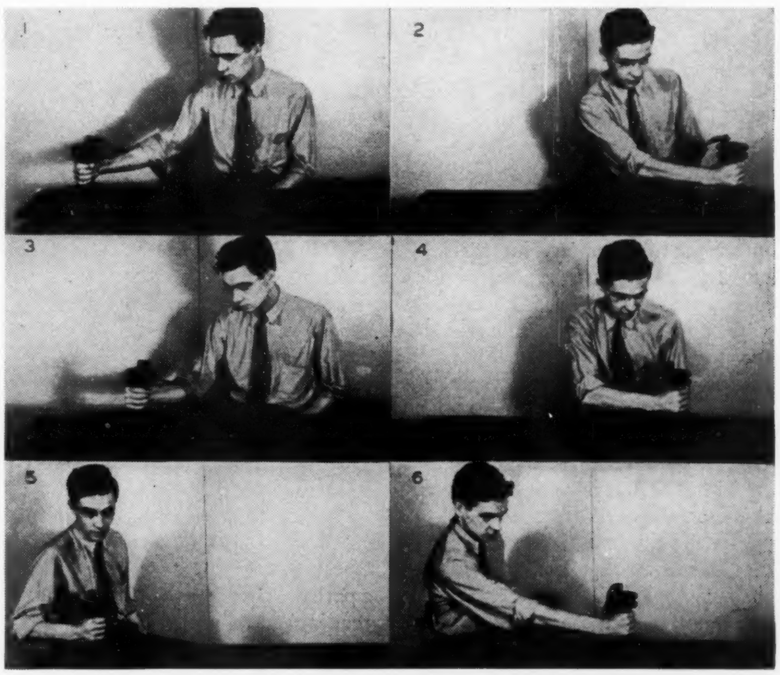


FIG. 1 STARTING POSITIONS FOR TEST MOTIONS
(1, Long forehand sweep; 2, long backhand sweep; 3, short forehand sweep; 4, short backhand sweep; 5, forward thrust; 6, pull.)

Contributed by the Management Division for presentation at the Semi-Annual Meeting, Milwaukee, Wis., June 17–20, 1940, of The American Society of Mechanical Engineers.

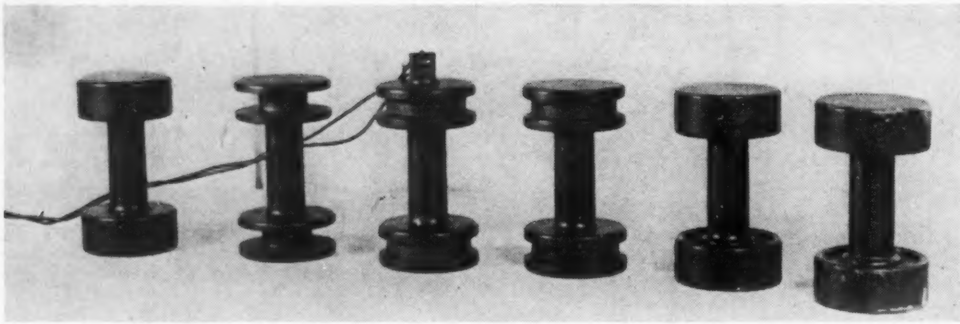


FIG. 2 ASSORTMENT OF WEIGHTS USED IN TESTS

(Third weight from left shows spark gap mounted on top; timed sparks trace motion paths and indicate time intervals.)

since it was desired to study the power expended in freely accelerating the weights without anticipating a definite stop.

All the test motions of each subject were made at one sitting to minimize variations in physical conditions and mental attitude. The weights were taken in the order of size, starting with the heaviest. The six motions with each weight were made in the order listed; all of the motions with one weight being completed before going on to the next. The subject made one trial motion just before each of the test motions.

The various motions taken in rotation utilize different arm muscles and lessened the fatigue of any one muscle. Some time was required between motions for adjusting the apparatus and this provided further rest.

The assortment of weights used in the tests, and details of their construction, are shown in Fig. 2. All of the weights were of the same size and shape, but were made of different metals and had grooves turned in the end sections to produce the proper differences in mass.

During the trials with each weight, a spark gap connected to an interrupted source of high-voltage current was mounted on top of the weight. This produced a series of accurately timed sparks throughout the movement of the weight, tracing the path of travel and recording the time intervals on a photographic film. This spark gap attached to one of the weights is shown in Fig. 2. It was connected to the source of current by two rubber-covered braided copper wires separated at intervals by rubber spacers.

Current for the spark gap was supplied by two high-tension ignition coils connected in parallel. The primary circuits of the coils were interrupted at definite intervals by a double-breaker timer of the type used in gasoline-engine ignition systems. The timer was driven by a constant-speed electric motor, but the time between successive sparks could be varied through the use of interchangeable gears. This method of analyzing hand motions is a further refinement of the chronocyclograph developed by the Gilbreths, and has been found accurate to within 0.0001 sec. The time interval used in this study was 0.01 sec.

A Leica camera equipped with an f3.5 lens of 35-mm focal length was used to photograph the timed sparks which traced the motion paths. The camera, mounted on a bracket extending over the table, photographed directly a top view of the motion showing the horizontal components of travel. A plate-glass mirror supported on top of the table at an angle of 45 deg reflected upward a side view of the motion, showing the vertical component thus enabling the side view to be photographed simultaneously on the same film. The general arrangement of the testing setup is shown in Fig. 3.

A photograph of the spark path of one of the test motions is shown in the upper part of Fig. 4. The lower series of points represents the direct top view of the motion, and the upper series is the reflected side view. The lower part of Fig. 4 shows one of the subjects in position for the start of the first type of motion, the long forehand sweep. This photograph was taken with the camera and mirror in the same positions as for photographing the actual test motions.

CALCULATION OF HORSEPOWERS

In this study, the power expended by the hand was determined by having the subject accelerate a weight of known mass, and measuring the distance traveled during each increment of time from the start of movement. The calculation of power from these three values of mass, distance, and time is based on the following fundamental relationships of mechanics

$$p = \frac{W}{t} = \frac{fd}{t} = \frac{mad}{t} = mav = \frac{w}{g}av \qquad [1]$$

where

t = a short interval of time
d = distance traveled during time t
v = average velocity during time t
a = average acceleration during time t
m = mass of body accelerated
w = weight of body accelerated
g = acceleration of gravity = 32.2 ft per sec per sec
f = average force applied to body during time t
W = work done on body during time t
p = average power expended during time t

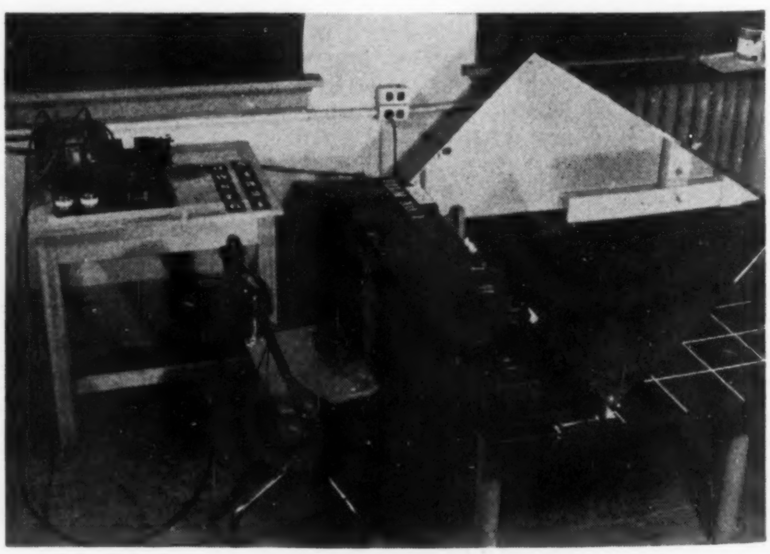


FIG. 3 GENERAL ARRANGEMENT OF TESTING SETUP. CAMERA SUPPORTED ABOVE TABLE PHOTOGRAPHED TEST MOTIONS

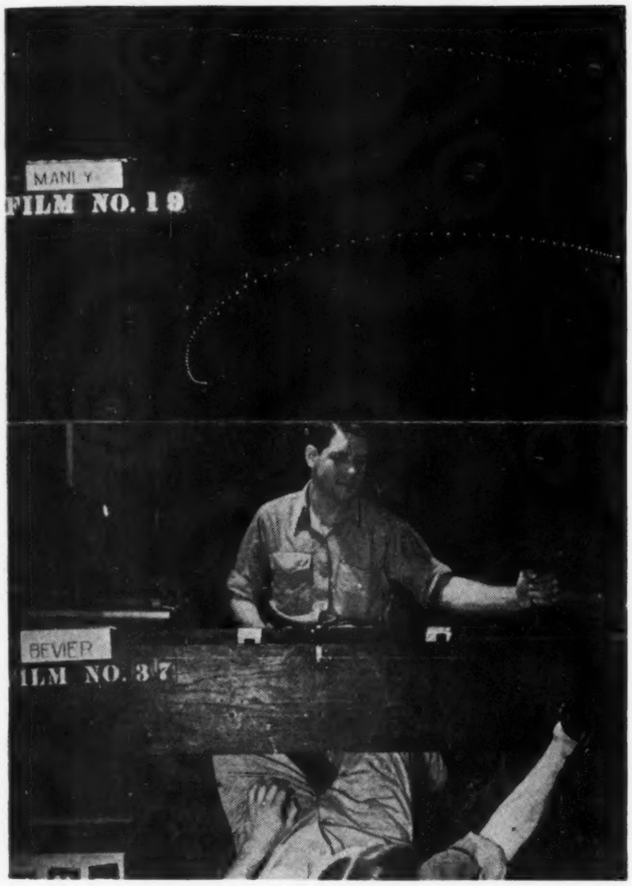


FIG. 4 TOP VIEW SHOWS SPARK PATH PRODUCED BY LONG FOREHAND SWEEP. BELOW IS SHOWN SUBJECT IN POSITION FOR START OF MOTION, PHOTOGRAPHED WITH CAMERA AND MIRROR IN SAME POSITIONS AS FOR ACTUAL TEST PHOTOGRAPHS

(Upper series of points is reflected side view of motion; lower row of points is direct top view.)

Equation [1] may be expanded

$$p = \frac{w}{g}(a_h v_h + a_v v_v) \quad \ldots\ldots\ldots\ldots\ldots [2]$$

where the subscripts h and v denote the horizontal and vertical components of the acceleration and velocity of the body. The horizontal component of acceleration is due entirely to the applied force and may be used directly in Equation [2]. However, it is apparent that the vertical acceleration of the body is the resultant of (a) the acceleration due to the applied force, and (b) the constant downward acceleration of gravity. To find the vertical acceleration due to the applied force for substitution in Equation [2], it is necessary to subtract the acceleration of gravity vectorially from the observed vertical acceleration.

The values of velocity and acceleration used for calculating the horsepower are derived from the linear displacement of the weight during successive time intervals. To determine the distance traveled during each interval, the spark path as photographed was projected on a sheet of paper to true scale and the positions of the sparks were marked.

Since the weight was closer to the camera and to the 45-degree mirror at certain times during its motion than at other times all increments of travel did not appear to the same scale in the photograph of the spark path. These photographic discrepancies were corrected by a graphical procedure through which true top, side, and end views of the spark path were constructed.

The displacement of the weight during each time interval was referred to three rectangular axes, and the component of travel parallel to each axis was measured. The resultant of the two horizontal components of travel was calculated, but the vertical component was kept separate because of the effect of gravity. Since the time interval between successive sparks was 0.01 sec, the displacement in inches during any time interval was equal to the velocity in inches per 0.01 sec. Thus, time-velocity curves for the horizontal and vertical components of movement were readily plotted. The acceleration of the weight at the end of each time interval was determined by measuring the slope of the time-velocity curve. The corresponding velocity at the end of each interval was read directly from the curve.

Substituting the numerical value of g in Equation [2] and multiplying by the proper constants gives the following equation in which the accelerations are in inches per (0.01 sec)^2 and the velocities in inches per 0.01 sec

$$\text{Horsepower} = 0.390\, w(a_h v_h + a_v v_v) \ldots\ldots\ldots [3]$$

The instantaneous horizontal and vertical components of the velocity of the weight, and the values of the acceleration due to the applied force were substituted in Equation [3]. In analyzing each test motion, the horsepowers at the ends of successive time intervals were calculated until the maximum instantaneous value was found.

RESULTS OF TESTS

Maximum Horsepowers. The maximum *instantaneous* horsepowers for the various weights, types of motion, and subjects varied from 0.11 to 1.6. The average of the maximum instantaneous values for all weights, motions, and subjects was found to be 0.47 hp.

The relationship between weight handled and maximum horsepower, Fig. 5, indicates that in general the weight handled has little effect on the power developed. This means that the handling of small lightweight parts in manufacturing operations may require as great an expenditure of energy as the handling of heavier pieces.

It is recognized that, in addition to the power expended in moving objects with the hand, there is an additional expenditure of energy required to accelerate the "dead weight" of the hand and arm. With the high velocities and rates of acceleration in the handling of lightweight objects, the power required to accelerate the hand and arm is greater than in handling heavier objects with lower velocities and lower rates of acceleration. Thus, if equal power is required in both instances to

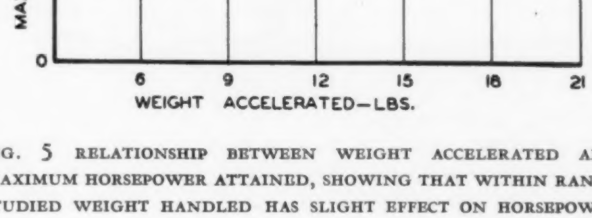


FIG. 5 RELATIONSHIP BETWEEN WEIGHT ACCELERATED AND MAXIMUM HORSEPOWER ATTAINED, SHOWING THAT WITHIN RANGE STUDIED WEIGHT HANDLED HAS SLIGHT EFFECT ON HORSEPOWER

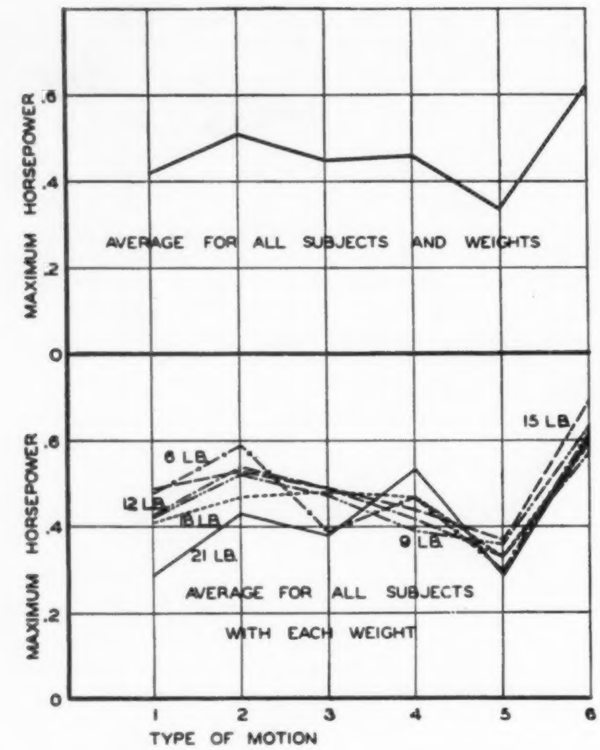


FIG. 6 RELATIONSHIP BETWEEN TYPE OF MOTION AND MAXIMUM HORSEPOWER

(For definitions of motions, refer to Fig. 1.)

produce the maximum acceleration of the object itself, it appears that the total power including that for accelerating the hand and arm will actually be greater for light weights than for heavier weights. In handling objects weighing only a few ounces the power required to accelerate and decelerate the hand and arm is a major portion of the total, while in handling objects weighing several pounds it becomes relatively insignificant. This emphasizes the advantage, in the handling of lightweight objects, of workers having small hands and arms. Assuming adequate muscular development, such individuals should experience less fatigue due to the acceleration of the "dead weight" of the hands and arms. Further investigation might show that this may partially account for the higher manual dexterity of women and girls in light assembly work.

The relationship between maximum horsepower and type of motion used is important in the placement of tools, parts, and materials around the work station in order to allow the worker to use the most effective motion paths. In the design of production machines, the location and direction of travel of control levers and handwheels should permit the use of a type of motion giving a maximum amount of power. The greatest power, as shown in Fig. 6, was developed with a pulling motion toward the body, the next greatest with a long backhand sweep from left to right, and the least with a forward thrust from a position at the side of the body. The other types of motion gave intermediate values. The upper curve in Fig. 6 represents the average of the maximum horsepowers developed by all of the subjects with all of the weights. The consistency of this relationship is indicated by the similarity of the lower curves, each of which represents the average of all subjects with a particular weight.

The Procter and Gamble Company has made use of these results in determining general rules to follow in setting up packing stations for its finished products. If the shipping carton, in which the finished product is to be packed, is placed on the far side of the products conveyer, the operator must use a pushing motion in setting boxes into the carton. If the carton is placed between the packer and the conveyer, a pulling motion is used in handling the boxes. Since the results of this study indicated that a pulling motion was preferable to a pushing motion, most of the packing stations have been arranged with the shipping carton between the operator and the conveyer to permit the use of the more effective type of motion.

The most striking result of this study was the consistency with which the individual subjects performed. Regardless of the weight handled or the type of motion used, the same relationship was found between the maximum horsepowers developed by the various subjects. This is shown graphically in Fig. 7, in which each curve in the upper chart represents the average of the maximum horsepowers attained with all motions with a particular weight. Each curve in the lower chart represents the average of the maximum horsepowers attained with all of the weights with a particular type of motion. The closer grouping of the curves, representing the various weights, was due to the fact that the weight handled had less effect on the horsepower than did the type of motion used.

In the course of this investigation, an attempt was made to find correlations between the power and velocity attained and the following physical measurements of the subject: Weight,

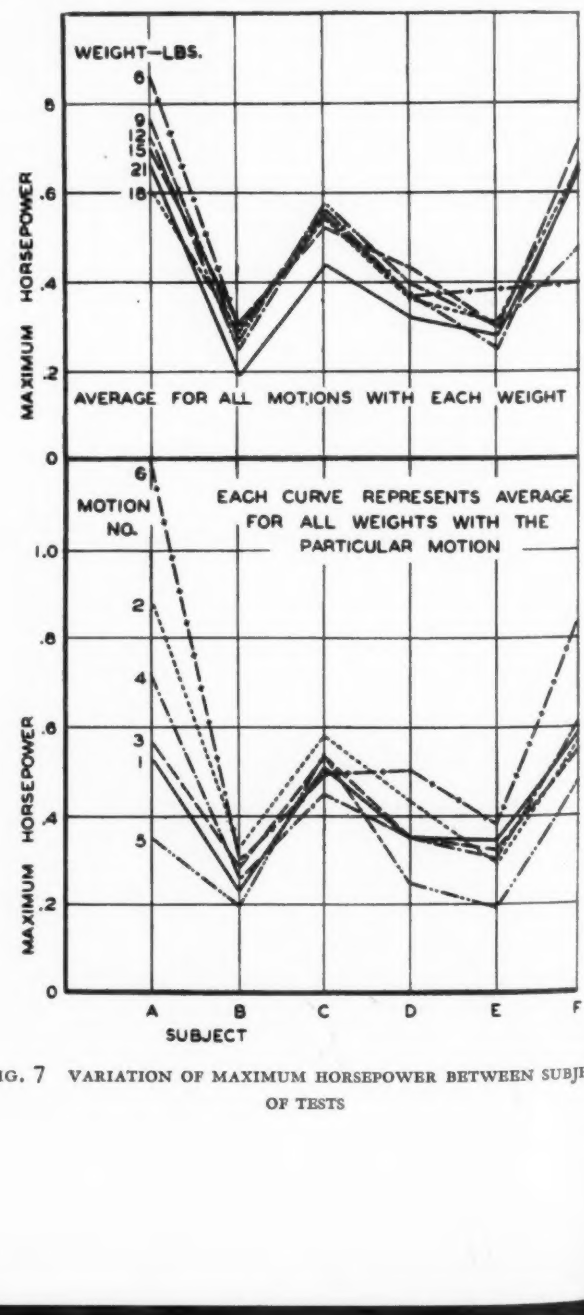


FIG. 7 VARIATION OF MAXIMUM HORSEPOWER BETWEEN SUBJECTS OF TESTS

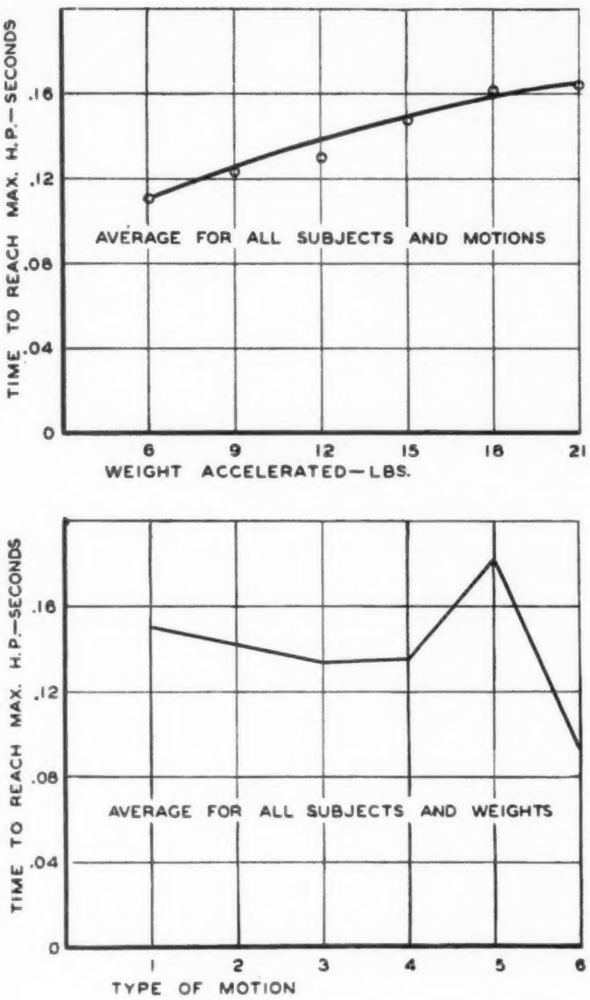


FIG. 8 UPPER CURVE: RELATIONSHIP BETWEEN WEIGHT ACCELERATED AND TIME TO REACH MAXIMUM HORSEPOWER; LOWER CURVE: RELATIONSHIP BETWEEN TYPE OF MOTION AND TIME TO REACH MAXIMUM HORSEPOWER

(For definitions of motions, refer to Fig. 1.)

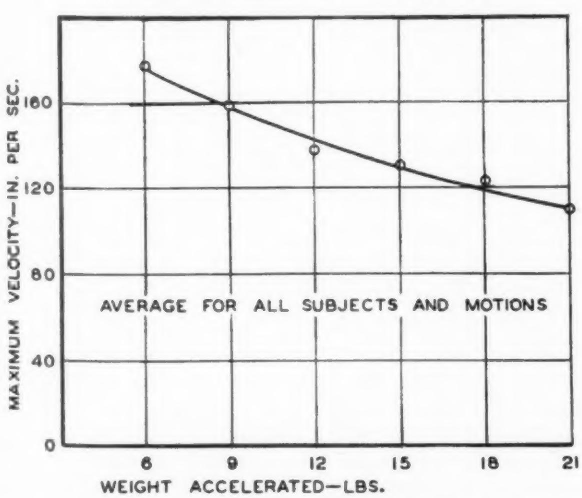


FIG. 9 RELATIONSHIP BETWEEN WEIGHT ACCELERATED AND MAXIMUM VELOCITY ATTAINED

(Curve is based on average of maximum velocities for all subjects and motions.)

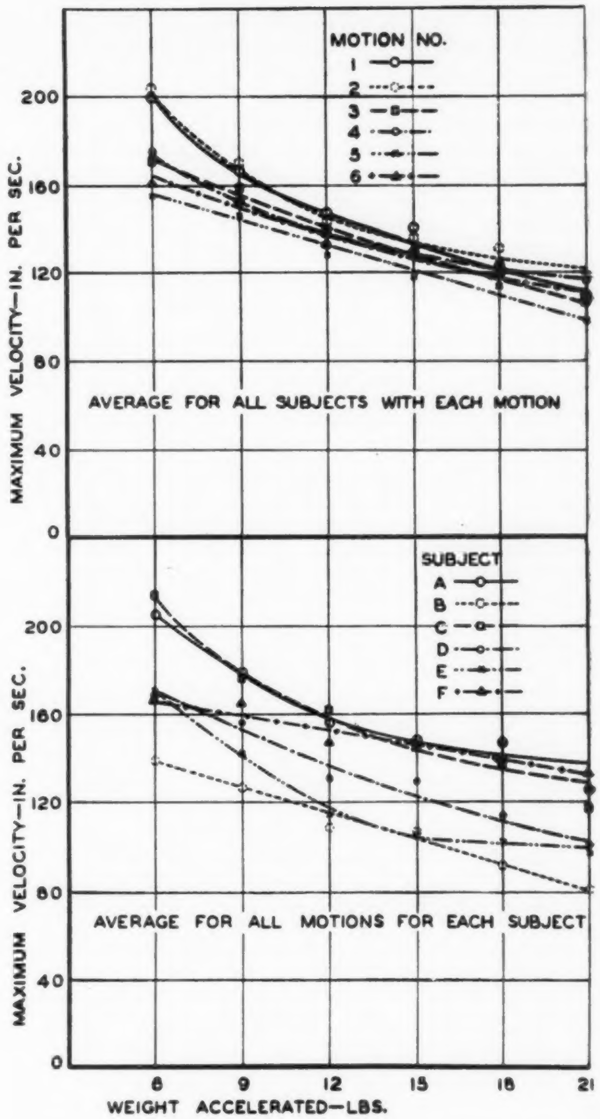


FIG. 10 RELATIONSHIP BETWEEN WEIGHT ACCELERATED AND MAXIMUM VELOCITY

(Upper curves represent different types of motion; lower curves different subjects. Similarity of curves shows consistency of relationship.)

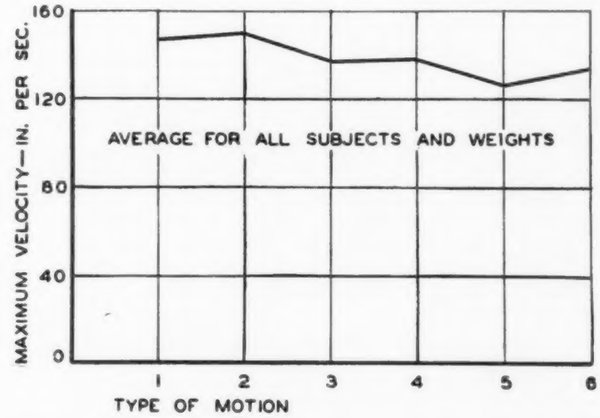


FIG. 11 RELATIONSHIP BETWEEN TYPE OF MOTION AND MAXIMUM VELOCITY ATTAINED, SHOWING THAT TYPE OF MOTION HAS LITTLE EFFECT ON MAXIMUM VELOCITY

(For definitions of motions, refer to Fig. 1.)

height, whole arm length, forearm length, size of upper arm at bicep, and size of wrist. Although no definite relationships were found between the power developed and the physical measurements made of the subject, the results emphasize the importance of individual differences in the selection of workers for various types of jobs. Definite correlations between power developed and physical characteristics of the individual might aid in selecting those most suitable for different kinds of work.

Time to Reach Maximum Horsepower. The horsepower developed at any instant in accelerating an object with the hand is measured by the product of the instantaneous velocity and acceleration. Thus, at the start of motion, the acceleration is great but the velocity is low and, as the velocity approaches its maximum, the acceleration approaches zero. Therefore, the maximum horsepower occurs sometime before the point of maximum velocity. The time from the start of motion at which maximum horsepower occurred ranged from 0.05 to 0.4 sec, the average being 0.14 sec. The relationships of the time to attain maximum horsepower to the weight accelerated and to the type of motion are shown in Fig. 8. The various subjects showed somewhat less consistency in time to reach maximum horsepower than in horsepower itself. The relationships of time to reach maximum horsepower to the weight handled and to the type of motion were also less consistent. In general, the maximum horsepower tended to occur earlier in the motions producing the greatest power. The maximum also occurred earlier in the motions made by subjects attaining the greatest horsepowers.

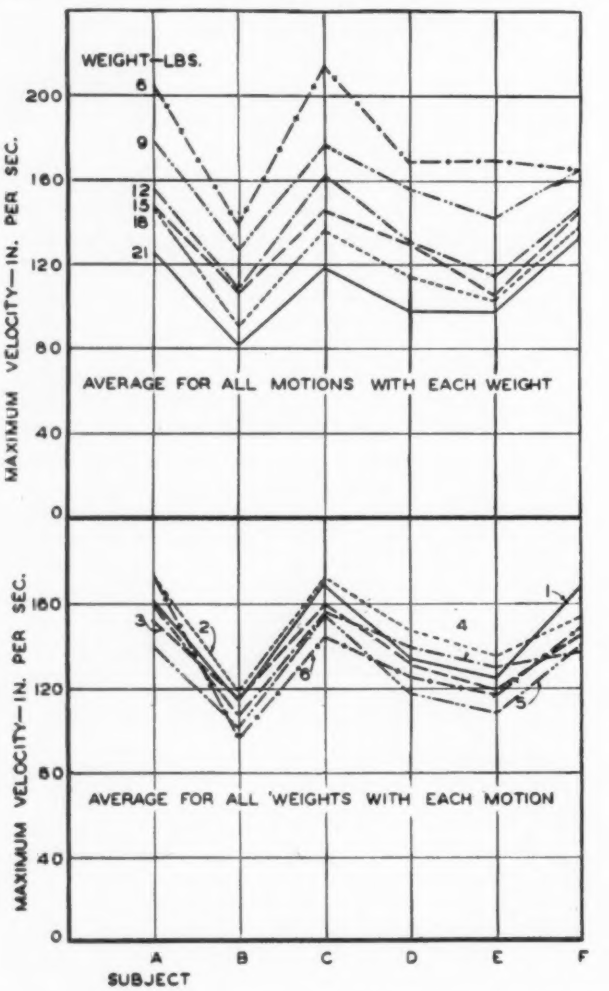


FIG. 12 VARIATION OF MAXIMUM VELOCITY BETWEEN SUBJECTS, SHOWING CONSISTENCY OF PERFORMANCE WITH VARIOUS WEIGHTS AND MOTIONS

(For definitions of motions, refer to Fig. 1.)

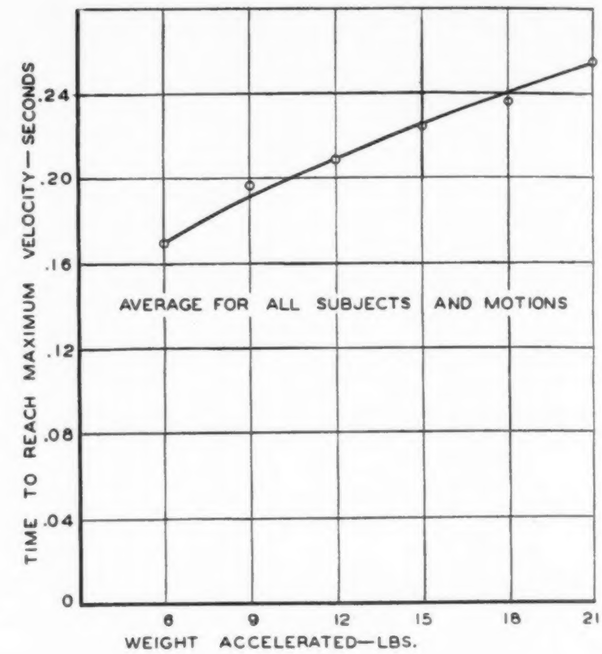


FIG. 13 RELATIONSHIP BETWEEN WEIGHT ACCELERATED AND TIME TO ATTAIN MAXIMUM VELOCITY

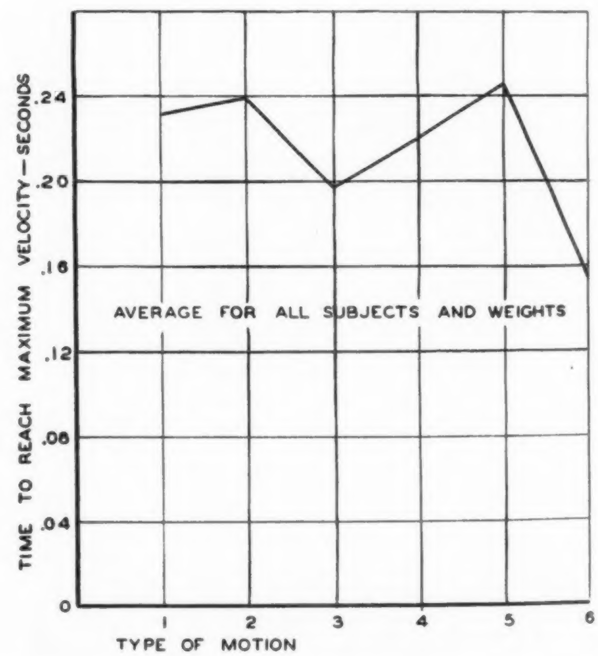


FIG. 14 RELATIONSHIP BETWEEN TYPE OF MOTION AND TIME TO REACH MAXIMUM VELOCITY

Maximum Velocities. The velocity of the hand with various weights and types of motion is an important consideration in all manual operations because of its relationship to the rate of production. The maximum velocities of the hand ranged from 72 to 259 in. per sec, the average of the maximum velocities for all weights, motions, and subjects being 139 in. per sec. The relationships of weight and type of motion to maximum ve-

TABLE 1 SUMMARY OF RELATIONSHIP BETWEEN INDEPENDENT AND DEPENDENT VARIABLES

	Independent variable					
	Weight accelerated		Type of motion		Subject	
Dependent variable	For different motions	For different subjects	For different weights	For different subjects	For different weights	For different motions
Maximum horsepower	small fair	small poor	large good	large fair	large good	large good
Time to reach maximum horsepower	large fair	large good	large good	large good	medium fair	medium poor
Maximum velocity	large good	large good	small good	small good	large good	large good
Time to reach maximum velocity	large good	large good	large good	large good	medium good	medium poor

NOTE: "Large," "medium," or "small" indicates extent to which weight, motion, or subject affects dependent variable. "Good," "fair," or "poor" indicates consistency of relationship.

locity were found to differ somewhat from the corresponding relationships to maximum horsepower.

As shown in Fig. 9, the maximum velocity was found to be inversely related to the weight handled. The consistency of this relationship is shown by the curves for individual motions and subjects, Fig. 10. The greater spread or dispersion among the velocity curves for different subjects compared to the curves for different motions indicates that the variation of velocities between subjects is greater than between types of motion.

While maximum horsepower was found to be definitely related to type of motion, no such relationship was found for maximum velocity. As shown in Fig. 11, the maximum velocity was not greatly affected by the motion used.

The variation of maximum velocity between subjects, Fig. 12, was consistent and followed closely the variation of maximum horsepower between subjects as shown in Fig. 7.

Time to Reach Maximum Velocity. The relationship between the weight handled and the time required to attain maximum velocity is shown in Fig. 13. Relationship between type of motion and time to reach maximum velocity is shown in Fig. 14. Consistency of these relationships was about the same as found for the time required to attain maximum horsepower.

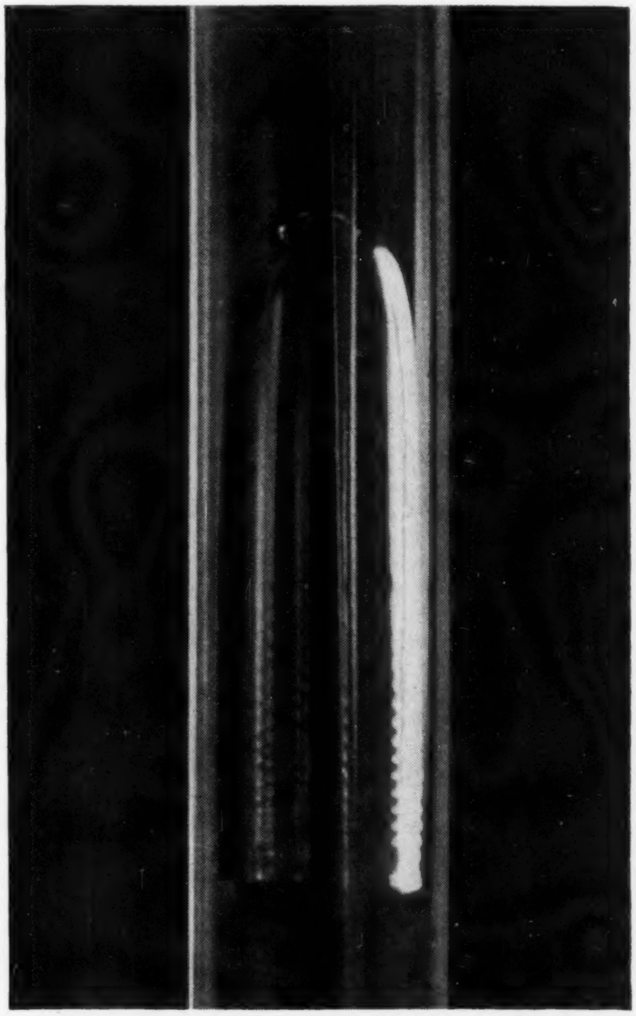
SUMMARY

Table 1 summarizes the relationships found between the three independent variables of weight, motion, and subject, and the four dependent variables, i.e., maximum horsepower, time to reach maximum horsepower, maximum velocity, and time to reach maximum velocity. The extent to which the dependent variable is affected by varying the independent variable is indicated in the table as "large," "medium," or "small." The consistency of the relationship indicates how widely it holds true, and is given as "good," "fair," or "poor."

The extent to which the dependent variable is affected is considered large if the dependent variable shows a wide range of values for the different values of the independent variable. In Fig. 7, the maximum horsepower varies widely between subjects, indicating that the independent variable (subject) has a large effect on the dependent variable (maximum horsepower). In Fig. 5, the curve is relatively flat indicating that, within the range studied, weight accelerated has a small effect on maximum horsepower.

The consistency is measured by the similarity of the shapes of the different curves for the particular relationship. Referring to Fig. 7, we see that the relationship between subject and maximum horsepower is represented by two sets of curves, one set based upon the average for all motions with each weight, and the other set based on the average for all weights with each type of motion. The similarity of the curves, representing the average for all motions with each weight, indicates that the consistency of the relationship for different weights is good. The similarity of the lower set of curves, representing the average for all weights with each motion, indicates that the relationship also has good consistency for different motions. If either of these sets of curves had shown a considerable difference in the shape of the curves, the consistency would be poor.

Table 1 includes several relationships which are negative or not consistent enough to be of practical significance, and which have not been illustrated graphically.



HYDROGEN BUBBLE

(Photograph by G. A. Hawkins shown at Fourth Annual Photographic Exhibit held at A.S.M.E. 1939 Annual Meeting in Philadelphia, Pa.)

30,000 ENGINEERING POSITIONS HAVE BEEN FILLED

Work Performed by the Engineering Societies Employment Service

By A. H. MEYER

EXECUTIVE SECRETARY, ENGINEERING SOCIETIES EMPLOYMENT SERVICE, NEW YORK, N. Y.

MORE than 20,000 regular positions in civil, mining, mechanical, electrical, and chemical engineering have been filled by the Engineering Societies Employment Service since its establishment in 1923 as a nonprofit and coöperative enterprise of the Four Founder Societies. In a recent survey of the members of these engineering societies it was found that about one third of the membership has been assisted by the Service, either in securing positions or in filling them. Up to the end of 1939, the three offices of the Service, which are located in New York, Chicago, and San Francisco, had registered 52,539 engineers for employment, received 42,523 positions for listing, and made 19,505 placements. These statistics do not include the placing of over 10,000 engineers on WPA and other governmental relief agencies during the years 1932 through 1939.

Considering the extraordinary conditions which have prevailed since 1930, the cost of maintaining and operating the Service during its 16 years of existence has been less than 17 cents per member per year. In normal times the cost of the Service to the participating societies is very small, because those actually placed by the Service pay a placement fee in accordance with the rates in effect in the different offices. The differences in these rates are determined by the license laws applying in the states in which the offices are located. There is no charge whatsoever made to any employer for listing and filling a position.

OPERATION OF SERVICE

Positions to be filled are received at each of the three offices through letters, telegrams, telephone, or personal interviews with employers. Because of the close personal relationship of the Service to the membership of the various engineering societies, positions are received from all sections of this country as well as from many foreign countries. Each position is carefully checked upon receipt (any questionable position is promptly rejected), then classified, given a key number, and written up in a brief and concise manner. This description, without the name of the employer, is posted in the "Positions Available Book," maintained in each of the three offices. Where the position is to be filled locally, only the office serving that locality will post the description in its book. To assist members who have registered with the Service but cannot come in person to the office during business hours, or who are located at a distance, there is published and supplied at cost to them a weekly bulletin containing most of the positions which have been received during the preceding week. A list of mechanical-engineering positions available, as many as space will permit, is also published every month in MECHANICAL ENGINEERING.

Any member of one of the Four Founder Societies may register without charge, whether he is employed or unemployed. In fact, the applicant pays no fee whatever to the Service at any time unless it is directly responsible for referring him to a position which he accepts, or unless he wishes the Service to conduct a special letter compaign for him. If a position should prove to be temporary, special rates apply. Registration, in person or by mail, is accomplished by the completion and filing of a registration card obtainable from any one of the three offices of the Service. Where a member so requests, this information will be kept in strict confidence by the Service. In addition to filling out a registration card, which is filed for ready reference in the office of the Service, the applicant is also requested to furnish several copies of his experience record. Each registrant also has the privilege of having a brief advertisement under a key number inserted free of charge in the journal of the Society in which he holds membership.

10,000 CLASSIFICATIONS

The success of the Engineering Societies Employment Service is based on a thorough and complete system of engineering-experience classification, which has been developed to its present stage after more than 16 years of experience. It is possible through this system of classification and indexing to file a member's registration in one or more of the 10,000 specialized engineering classifications covered by the system. Whether the registrant is a recent college graduate or a chief engineer with many years of experience, his record will receive the same consideration and careful scrutiny of the staff in order to classify it according to his experience and desires. This makes it possible to locate almost immediately a qualified engineer to fill any of thousands of positions in engineering and allied fields. Since an employment service of this type must cater not only to members looking for positions, but also to those looking for men, it is necessary at times to go outside the membership for qualified engineers.

When a position is received, experience records of qualified applicants are selected by means of the classification system and duplicates forwarded to the employer. Whenever possible, the employment manager of each of the offices tries to convince the employer company that much time, money, and effort on its part can be saved if the Service is permitted to make the selection of qualified applicants for personal interviews. As figures which will be given later in this paper, show the personal-interview method of placement is much more efficient and works to the advantage of the employer and, without doubt, to the advantage of the prospective employee. Where this method is used, the Service promptly notifies the applicant and arranges for the interview. Unfortunately, in spite of efforts of the Service in this direction, less than 25 per cent of the positions specify or permit direct referral.

As explained before, open positions are published in the *E.S.E.S. Weekly Bulletin* and in MECHANICAL ENGINEERING.

A member, who is interested in one of the listed positions but cannot get in touch with the Service directly, may send in a special letter of application addressed to the key number of the position listed, or can simply send in a post card requesting that his application be considered, in which case, a copy of the experience record from the office files will be forwarded to the employer. When sending in a letter of application, six cents in postage should be included, three cents to forward the application to the employer, and three cents to return it to the applicant after it has been returned to the Service by the employer. In many cases applicants will send drawings, original reports, or letters of reference, in spite of the fact that the Service does not recommend forwarding this information in an original application and assumes no responsibility for its return. After an application has been forwarded to the Service, it is not necessary to follow it up with a lot of needless correspondence. Unfortunately, because of a limited staff and the tremendous number of applications and positions with which the staff is constantly working, it is a physical impossibility, without going to a great deal of extra expense, to acknowledge receipt of each application. The applicant can be assured that his application will be transmitted to the employer, provided of course, he has the necessary qualifications, and, if the employer is interested, the Service will lose no time in promoting further contact.

At the present time, the Engineering Societies Employment Service has about 8000 active registrants, and sends out approximately 3000 experience records and receives an average of 400 positions per month.

Through its three regional offices, the Service is able to operate with the least possible handicap regardless of the geographical locations of employer and of employee. However, the Councils of the participating Societies have already gone on record concerning the desirability of spreading the Service throughout the membership area by the eventual establishment of additional offices in other industrial areas. Regional offices permit personal examination of an applicant's qualifications, personality, and appearance, thus making possible a more efficient and intelligent classification of an application. Furthermore, this plan is also of benefit to local employers because it is possible to obtain more complete and detailed specifications of their requirements and direct referrals can be made more easily.

Examining statistics of the Service, it is seen that approximately 50 per cent of all positions received within 100 miles of an operating office have been successfully filled, while the percentage of positions filled outside the 100-mile radius is only about 18 per cent. Another interesting fact is that 67 per cent of positions are filled by direct referral as against 33 per cent by correspondence or letter of application.

VOCATIONAL GUIDANCE

Another function of the Service, which is usually missing in an outside commercial agency, is that of vocational guidance. Not having the necessary staff and finances, the Service cannot go as far as it would like to in counseling members about their professional lives, but whenever possible, each applicant is given a personal interview in order to discover his "selling points" and suggestions are made as to the type of position for which he is best qualified. Oftentimes, the lack of certain training is called to the applicant's attention so that he can take steps to get it, either in his present position or in a college postgraduate course. The work of the New York office in this direction has been supplemented during the last year through the cooperation of the Vocational Guidance Committee of the A.S.M.E. Metropolitan Section's Junior Group.

Many engineers know very little about how to go about applying for and getting a position. It certainly seems that after these many years, some definite method should have been evolved which would make the task of finding a job relatively simple. Many books have been written and ideas have been promoted by different specialists, most all of whom offer some very good suggestions. Since this paper concerns the work of the E.S.E.S., it is not the intention of the writer to go into a lengthy discussion on "How to Find a Job." He would like to be able to say, "Register with the E.S.E.S. and your problem will be solved immediately for you," but since more than twice as many applications as compared to positions available are received, a great many people would take exception to such a statement. It is the contention of the writer that there is no positive rule or formula which will always produce results. Because the task of finding a job is fundamentally a matter of salesmanship, the man who has the most to sell (experience, age, appearance, personality, alertness, education) invariably gets the job. Therefore, when registering or applying for a position through the Service, great care should be given in the preparation of one's application. It should give a complete picture of what the applicant has to offer, but at the same time should be brief and concise and should not contain amplifying details. The application must be neat and clear, preferably typewritten, and have attached to it a recent photograph of the applicant.

A suggested form to follow is shown below:

Name..................	Religion......................
Address...............	Location preferred............
Age....................	Will you go out of town?.....
Height................	Languages.....................
Weight................	Engineering societies
Married...............	membership and grade......
Children..............	Registered engineer and State(s)
Citizen...............	....

Educational Record

(Includes name of school, course, year graduated, degree, special studies, honorary societies, and honors)

Experience Record

(Includes dates and titles of each position, its functions, man's responsibilities, kinds of work or equipment handled, and names of companies)

COOPERATION NECESSARY

As the Engineering Societies Employment Service is in reality a special department of each of the Four Founder Societies, the effectiveness of its work depends upon the cooperation and support accorded to it by the individual members. As stated before, at the present time a small amount of financial assistance is rendered by the A.S.M.E. and the other national engineering societies to the Service. This aid would be entirely unnecessary if more members would utilize its services in getting men or positions.

In spite of the fact that the Service has been in operation for so many years, many employers are still unaware of its existence. Many well-qualified engineers have not registered because they were not acquainted with the Service or, not holding membership in one of the cooperating societies, thought that only members were permitted to do so. However, while members of the A.S.M.E. and the other societies are given first consideration for any openings, nonmembers may now register in accordance with this understanding.

Local sections and local engineering clubs and societies could be mutually helpful by including a regular line in the margin of meeting notices or in their publications, stating that the

(*Continued on page 396*)

REVIEW *of* PROGRESS *in* FEEDWATER TREATMENT

By C. H. FELLOWS

RESEARCH DEPARTMENT, THE DETROIT EDISON COMPANY, DETROIT, MICH.

TREATING water for use in steam-generating equipment is not new. The controlled application of scientific principles to the problems involved is, however, of comparatively recent origin. The present paper will first consider briefly the general problem of feedwater treatment, indicating those changes in the practice that have occurred principally as the result of the general use of higher pressures and temperatures in the generation of steam, and then will outline in some detail the present methods used within the industry and discuss some examples of those methods.

Although some new processes and new methods of application of the commonly used chemicals have been developed, the same basic objectives of the treatment of water for steam-generating purposes exist today under operating pressures of 600 psi and higher as when pressures of the order of only 200 and 250 psi gage were in use. There has been, during this development of higher-pressure operation, a marked change in the general conception of the importance of correct feedwater treatment, and as a natural result the exactness of the art has been stressed. This phase of the application of chemistry to industrial processes is one in which accuracy in the practice has supplanted inaccurate or sometimes haphazard efforts as the principal change in the art.

Among the most important problems in the generation of steam at the present-day high-pressure operation are those of the chemistry of the materials used. These concern principally the water used together with its salts and gases in relation to the confining metals. The solution of these problems lies in a large measure in the treatment of the water before it enters the boiler in combination with additional treatment, in many instances, during the steam-generating process.

It is not the intention of this paper to present the details of the early efforts to prepare water for use in boilers, but a brief chronological review is given as an introduction to modern practice. First, purification of water began as simple settling of suspended matter. Then filtration followed, and chemicals designed to coagulate the suspended matter to speed up settling and increase the efficiency of filtration were introduced. Once started, this use of chemicals was rapidly developed to the point where they were employed to react with and precipitate certain of the scale-forming salts and permit their removal by settling or filtration before the water entered the boiler.

Today, depending upon the nature of the dissolved salts in the water and the use to which the steam generated from it is to be put, water may be treated outside the boiler, inside the boiler, or both outside and inside. Pretreatment, that is, the treatment carried on outside of the boiler, may involve either the addition of chemicals and the subsequent removal of the reaction products by settling or filtration, or it may involve raw-water distillation whereby only the condensed vapors are used as boiler feedwater.

Contributed by the Power Division for presentation at the Spring Meeting, Worcester, Mass., May 1–3, 1940, of The American Society of Mechanical Engineers.

I—OBJECTIVES OF FEEDWATER TREATMENT

The basic objectives of feedwater treatment are:

(1) The prevention of hard scale on the heating surfaces of the boiler.

(2) The elimination of corrosion in all parts of the steam-water cycle.

(3) The prevention or control of carry-over to preclude adherent deposits in superheaters and on turbine blades.

(4) The inhibition of caustic embrittlement.

Although these objectives of feedwater treatment have not changed in the course of the development of steam-generating equipment, their significance in the over-all efficiency of boiler operation is now being emphasized to a far greater extent than formerly. At the outset it was sought to prevent the settling out of mud from suspended matter and the precipitation of scale from certain salts in solution in the natural water. Little or no attention was given to corrosion in the early days of steam-boiler operation because, as a rule, the boiler surfaces were so coated with mud and scale that direct contact of the metal with corrosion-producing elements was not possible. Particularly in the case of certain types of raw water, and generally as the operating pressure was increased, it became necessary to prevent foaming and carry-over of boiler water with steam. This need stimulated the more careful use of treating chemicals and the reduction of the concentrations of dissolved salts and suspended matter in the boiler water. Efforts in this direction tended to reduce the amount of scale and mud deposited on the steam-generating surfaces, and as a result corrosion began to occur. The battle against corrosion in boilers has been waged actively during the last twenty or thirty years.

The maintenance of high alkalinities in the boiler water was long the principal means used in combating corrosion, and only within relatively recent years has the removal of oxygen as a means of preventing corrosion been practiced to any major extent. At the present time oxygen is considered to be the primary cause of corrosion in the boiler proper, although there have been manifestations of corrosion in high-pressure, high-temperature units that are obviously not entirely the result of oxygen in the water. Steps have been taken that have resulted in the practical elimination of dissolved oxygen, and a marked reduction in the severity of corrosion has been realized. In the superheater, however, with the nearly perfect elimination of oxygen in the boiler feedwater of central-station plants and in some of the large industrial plants, corrosion due to the dissociation of steam in contact with the hot metal which gives rise to nascent oxygen or to the direct reaction between steam (H_2O) and the hot metal, is an important factor.

The importance of steam purity has been emphasized as the result of efforts to attain increased efficiency of boilers and steam turbines. The practical manifestations of impure steam are (1) scaled superheater tubes and (2) deposits on turbine blades of the soluble salts in the boiler water carried by the steam. C. W. Foulk and his associates at The Ohio State Uni-

versity have contributed much to our knowledge of the phenomenon of "carry-over." Present-day water-treating practices aim in part at the elimination of carry-over or its control to the extent that harmful effects of its occurrence are not evident.

The prevention of "caustic embrittlement," the phenomenon of intercrystalline corrosion of highly stressed boiler metal, has been, for 30 years, one of the least understood objectives of boiler-water treatment. Its occurrence in the more modern high-pressure boilers has not as yet been observed. The reason, in spite of intensive investigations, is still a subject of controversy. There are some who hold the opinion that more careful fabrication and assembly than was possible in the case of the low-pressure boilers, and the concurrent use of welded construction and the practice of stress relieving these higher-pressure units afford the principal reason, while others are of the opinion that boiler-water treatment has eliminated this type of trouble. Undoubtedly, both elements have contributed, although the older methods of chemical treatment obviously appear to be not entirely adequate in controlling intercrystalline cracking.

II—METHODS OF FEEDWATER TREATMENT

Now that the objectives of boiler-water treatment as practiced today have been considered, the manner by which operators are seeking to control water conditions and attain these objectives may be reviewed briefly.

SCALE PREVENTION

In nearly every instance in which boiler feedwater is treated, the primary reason for the treatment is to prevent the formation of hard scale on the boiler heating surfaces. Fundamentally, most waters can be treated chemically to prevent scaling by the use of sodium carbonate, i.e., soda ash, or one or more of the sodium-phosphate salts. Operating conditions generally dictate which shall be used. Sodium carbonate is, of course, used either as an internal treatment or as an adjunct in the hot or cold lime-soda external softeners, whereas phosphates are almost always used in internal treatments. Phosphate salts have other valuable properties in feedwater treatment besides their ability to prevent scale through reaction with the calcium and magnesium salts in the water. The phosphate ion has been considered by a number of chemists as a preventive of embrittlement. Moreover, the precipitated phosphate salts have the property of adsorbing small amounts of oil that may enter the system.

For scale-preventive treatment there are also the base exchange processes using natural or artificial zeolites. A recent development in this class of water-treating equipment is the acid zeolite. This zeolitic material liberates most of the potential carbon dioxide from the water. It is regenerated with sulphuric acid and is used in conjunction with the normal zeolites which develop basic characteristics in the water and impart no silica to the water. Among this class of water-treating equipment is that one considered to be in the experimental stage of development using synthetic resins as the exchange material. Manufacturers of such equipment report that with the proper selection of exchange medium practically all of the salts in solution can be removed so as to produce virtually distilled water.

The standard hot lime-soda softeners have been made more effective, first, as to their efficiency through the use of coagulants to remove more completely the scale-forming salts before the water enters the boiler, and second, because the use of phosphate as internal treatment assures more complete removal of residual calcium and magnesium.

Colloidal treating compounds are receiving much attention at the present time, and the chemists in the power-station industry are studying these in an effort to evaluate them fairly. They may be divided into two general classes: Those which contain but a single salt or element and are used primarily as oxygen scavengers, although in the case of some the ability to remove silica is reported (1);[1] and those which combine with the organic material the commonly used salts of water treatment, sodium carbonate or the phosphate salts, as the basic reactive elements. Among the first class are those which contain colloidally dispersed metallic iron or ferrous salts, and in the second class may be found the organic compounds, extracts of seaweed, hemp, and sugar cane with which inorganic salts may or may not be combined to form the complete treatment.

Exact knowledge of the reactions in boiler water of many of these organic compounds is not available, but reported success in their use has become widespread, especially in the lower-pressure, small industrial plant and to some extent where rust or deposited scale is to be removed from hot-water systems.

In addition to the foregoing processes of treating feedwater and boiler water, which depend upon the well-established reactions between common chemical compounds and the salts found in industrial waters, there is the rather large variety of so-called electrolytic systems. Such systems depend upon an imposed electromotive force acting in a direction, with respect to boiler metal, opposite to that naturally occurring as the result of the proximity of the salts and gases in the water and the confining metal. Theoretically, such systems redirect the natural movement of ions away from the boiler metal, thus preventing their deposition and ultimate accumulation as scale or oxides. Actually, their successful operation in boilers has not been conclusively demonstrated. The impossibility of obtaining uniform current density on all surfaces of the boiler metal seems to be the principal reason for the lack of the general adoption of such systems for steam-generating application.

CORROSION PREVENTION

Although the processes of treatment just discussed are applied primarily for the purpose of preventing scale, some are used also in combating corrosion. Corrosion of boiler metal in the present high-pressure, high-temperature steam generators presents a more serious problem than that of scale. Distillation, pretreatment, or external treatment can be depended upon to remove successfully all scale-forming salts. Properly selected and supervised internal treatment in the case of some types of water can also control the deposition of scale made possible through partial or imperfect treatment outside the boiler. Corrosion, unlike scale formation, however, cannot be so easily controlled. Even though all scale-forming salts are removed from the water, corrosion of the metal may still proceed. In fact, the complete removal of salts capable of forming scale or less adherent deposits intensifies the possibility of corrosion of the metal at the higher operating temperatures. Dissolved gases, principally oxygen, but also carbon dioxide, are usually the offenders in these instances. Operators of high-pressure, high-temperature boilers strive with all diligence to rid their boiler feedwater of dissolved oxygen. Too much emphasis cannot be placed upon the necessity of oxygen-free boiler feedwater if serious corrosion is to be prevented.

A great many processes have been offered to combat the presence of oxygen. Deaeration is the most common method used in large power plants, although it is not entirely adequate in all cases. Even though deaerators may completely remove the oxygen from the water entering them, operating conditions independent of the deaerators, such as the starting and stopping of pumps or the starting of main and auxiliary units, may serve to permit the spasmodic ingress of air to a feedwater system

[1] Numbers in parentheses refer to Bibliography at end of paper.

beyond the deaerators, and necessitate special treatment to "fix" the oxygen thus entering. Treatment in such cases may be sodium sulphite, colloidal iron, or organic materials such as the tannins, chestnut extracts, or similar reagents.

Much has been written recently regarding these specifics for dissolved oxygen (2, 3), especially regarding sodium sulphite. The fear has been that this salt might decompose in solution to produce a gas that when dissolved in condensed steam would prove to be corrosive. The present opinion of investigators of this subject is that when sodium sulphite is used in the low concentrations required to combat the small amount of oxygen generally present when this type of treatment is called for, and in normally functioning boilers, decomposition will not occur. It may occur, in solution, however, when the concentration of sodium sulphite is high, or it may occur when that salt exists in the dry state deposited in "dry" areas as the result of imperfect circulation of boiler water.

As already mentioned, carbon dioxide as well as oxygen is now looked upon as being a primary offender in the development of corrosion. The removal of this gas from systems handling large quantities of condensed steam materially reduces the corrosion of the lines carrying the condensate. Raw waters containing high concentrations of bicarbonate and carbonate salts and used as the source of a boiler supply have been successfully treated to eliminate nearly all of the carbon dioxide potentially available in such waters. Treatment adopted in such cases involves acidification with highly ionized acids as sulphuric or phosphoric, aeration, or gasification, followed by final deaeration.

Recently there have come to light several instances of a type of corrosion in which dissolved oxygen is not considered a factor (4). There are cases where grooving, serious pitting, and cracking have occurred on the steam side of boiler tubes, which in some cases is the upper inside surface. Such studies as have been made and reported of these cases point to imperfect circulation as the fundamental cause of the corrosion, that is, lack of proper circulation produced an environment that permitted the attack of the metal by solutions in contact with it. Like so many instances of corrosion in steam boilers, this type of corrosion seems to present the problem of combating it by one of two means, chemical or mechanical. There is little doubt but that the power-station chemist, once the reactions concerned are understood and provided the reaction is not one involving the dissociation of steam alone, will be able to adjust the salt concentration of boiler water to prevent corrosion in this particular environment. How much more logical it would be for the mechanical engineers and designers to eliminate in the first place the fundamental cause by correcting the circulation in the unit and by insuring equipment having a heat-absorbing capacity great enough to prevent steam blanketing at the maximum combustion rate. The efforts of boiler designers in their attempts to design and fabricate a perfect unit should not be underrated. Difficulties of this nature are frequently the price that is paid for development in the art and are solved as progress continues. It should be pointed out, however, that many of the industry's problems of corrosion are capable of being solved both in the design stages and, subsequently, by purely mechanical methods without recourse to chemistry.

A pertinent example of this concerns the effort being made in research groups supported by industry to determine the basic data in the broad reaction between steam at elevated temperatures and metals to be used in the fabrication of superheaters and steam piping especially designed for high-temperature operation. The Detroit Edison Company, as early as 1926, undertook studies designed to indicate the trends in this reaction between steam at high temperatures and the then available alloy tubing. Notable studies, undertaken subsequently at Purdue University and at the University of Michigan, already published in part, are providing the foundation for the rational selection of alloy tubing for this service. As a result of such research, the industry is now in a position to combat the destruction of metal in high-temperature steam generators by this corrosive influence by providing a mechanical environment that is not reactive.

There are, of course, problems of corrosion that cannot be solved without the aid of chemistry. Among such, in the light of our present knowledge, is the problem of caustic embrittlement as encountered in existing boilers. All other factors being equal, it appears that the chemical environment of boiler metal, adjusted to eliminate the possibility of embrittlement as suggested in the A.S.M.E. rules for care and maintenance of boilers, is not infallible. Continued research has indicated that sodium sulphate cannot be relied upon to inhibit the development of caustic embrittlement under all conditions. Lignins such as occur in sulphite waste liquor have been found in the laboratory and in a limited number of service cases to prevent embrittlement of boiler steel under operating temperatures up to about 500 F. There has been experimental as well as some practical evidence that sodium chloride in conjunction with the sulphate ion in boiler water has functioned as an embrittlement preventive. Present knowledge, however, does not justify the general recommendation of the use of these materials without careful supervision by those who are intimately familiar with the phenomenon. As more information is gained through research and the channels of practical experience available to investigators of this problem, its release to operators may be expected.

CARRY-OVER PREVENTION

The treatment of feedwater or boiler water to control either the extent of carry-over or its nature is not as effective in some cases as it should be. Much work has been done on the subject by Foulk, Brill, and Ulmer at The Ohio State University, and at the University of Illinois by Straub and his associates. At Ohio State the foam-producing and carry-over characteristics of boiler waters as affected by various concentrations of typical salts found in them have been determined. This work as summarized by Foulk and Ulmer (5) indicates that of the commonly found soluble salts in boiler water sodium phosphate, calculated as an anhydrous salt, produces carry-over at lower concentrations than the other salts. On the other hand, sodium aluminate, if it were in true solution, could be present in concentrations equal to twice that of the phosphate salt before carry-over would occur. When expressed in terms of equivalent sodium-chloride effect, it is reported that the effect on carry-over of all soluble salts is additive. In regard to suspended solids in boiler water, these same investigators conclude that certain ratios of calcium carbonate and magnesium hydroxide may exist in concentrations more than twice as great as magnesium hydroxide alone in the presence of sodium hydroxide before carry-over begins. In all cases the physical state of the precipitated solids was found to be a controlling factor. This work is important in that it evaluates the foam-producing properties of boiler-water salts and compounds and enables operators to relate this laboratory work to actual boiler practice.

Professor Straub has proposed to control the nature of carry-over by counteracting the sticky quality of sodium-hydroxide deposits with sodium sulphate (6). His work indicates that if a ratio of 4.4 to 1, sodium sulphate to sodium hydroxide, respectively, is maintained in the boiler water, adherent deposits will not occur. A survey of a number of power-plant records of boiler-water conditions served to indicate that ad-

herent deposits on turbine blades, a result of carry-over, were not in all cases a function of the proposed ratio of 4.4. In certain cases, however, where this ratio has been intentionally maintained for this purpose, successful inhibition of adherent deposits in the case of carry-over has been realized.

Steam washers of a variety of designs are being used with considerable reported success to prevent the carry-over of boiler water into the steam space. Even in the case of the use of such steam washers the power-plant chemist attempts to control foaming of the boiler water by judicial maintenance of proper concentrations of dissolved and suspended solids.

III—APPLICATION OF FEEDWATER TREATMENT

The application of our knowledge of feedwater treatment to any specific job requires the balancing of the effects produced by the several available processes, with the conditions known to exist as well as with those that may possibly exist in the normal course of operating boilers and steam-consuming equipment. For example, in a plant operating on a condensing cycle and supplied with evaporated make-up there would seem to be little fear of scale formation in the boilers, and any treatment required should be designed only to prevent corrosion, carry-over, and possibly the development of embrittlement. In some cases, depending upon the likelihood of condenser leakage and upon the nature of the cooling water, a small amount of scale may form. In the high-pressure type of boiler even a small amount of scale is dangerous and sound treatment should guarantee protection in the event of such leakage.

Another case applicable to the same type of boiler equipment concerns the choice of methods to protect against embrittlement. If the boiler feedwater is so free of dissolved alkali-producing salts that the desirable pH range of 10.5 to 11 is not attained in the boiler water and as a result conditions more favorable to corrosion exist, it may be necessary to add an alkali salt to the water. From this consideration arises the question of protection against embrittlement, and the natural procedure would be to add sodium sulphate in accordance with A.S.M.E. suggestions. However, the presence of the sulphate ion in the water, together with the possibility of leaky condensers admitting raw water containing scale-forming salts, would make the chance for the deposition of hard scale highly favorable, and further treatment would be necessary to counteract that tendency. The early work of Professor Straub, recently further substantiated, had indicated that the phosphate ion in proper concentration was capable of preventing embrittlement at pressures up to roughly 400 psi gage. The logical treatment of this situation with these facts in mind would be, therefore, to inhibit the development of embrittlement with phosphate, which can be maintained in excess of that value necessary to remove the scale-forming salts from the water, thus two additions only are necessary instead of three.

There is a tendency, in the treatment of boiler water or boiler feedwater, to add more chemicals than are actually necessary—to overtreat—and thus fill the boiler with unnecessary and undesirable quantities of both soluble and insoluble salts. This practice intensifies the possibility of carry-over. A good fundamental rule to observe, where economically possible, is to reduce all salts in the water in the boiler to a minimum. In most high-pressure boilers the concentration of dissolved solids is maintained at 500 ppm and lower.

There is, however, a growing tendency on the part of industrial plants to treat installations requiring a high percentage of make-up water by those processes that do not reduce the solid content of the water to a minimum, and to depend upon the adjustment of relative concentrations of specific ions in the water to eliminate scale. Such systems require high-capacity heat exchangers to conserve heat losses due to the excessive blowdown necessary to keep the total concentration of salts below that value which will cause foaming and subsequent carry-over.

The effectiveness of any treatment will be greatly enhanced by the judicial use of coagulants to flocculate the precipitated and suspended solids. Perhaps the most widely known chemical compound used for this purpose is sodium aluminate, and organic compounds have been used successfully in this respect.

An example of well-designed experimental treatment based upon sound theoretical considerations, for a boiler operating at 1200 psi and using distilled water with a low proportion of evaporated make-up, is as follows: The treatment is designed to prevent scale, corrosion, and embrittlement. Scale is prevented by the use of phosphate, but an excess of the phosphate ion is not maintained, thus permitting a slight residual hardness in the boiler water. This is done deliberately to reduce the possibility of carry-over and to provide calcium ions with which, in the presence of colloidal iron, silica will combine and be prevented from entering into those reactions which, in combination with caustic, have been shown to cause embrittlement. Colloidal iron is used primarily as an oxygen scavenger. Although its economy for this use alone might be questioned, it is justified because silica removal is necessary. R_2O_3 is also added as an embrittlement preventive at the high operating temperatures prevailing. Although carry-over is not anticipated and has not been encountered in the several months of operation of this unit, the complete removal of silica by both R_2O_3 and the calcium precipitation insure no adherent deposits on blades if carry-over did occur.

"Is it necessary to treat to prevent embrittlement in high-pressure boilers?" is a question frequently asked in the power-station industry. It is evident that this question would not be asked unless some difficulty has been encountered in the attempts to treat the water in accordance with prescribed recommendations. The assumed value of the A.S.M.E. ratio of sodium sulphate to total alkalinity for this purpose has become so firmly established in the minds of many operators that any plan of feedwater or boiler-water treatment automatically includes, where necessary, the addition of enough sulphate ions to maintain that ratio. The question is undoubtedly prompted by two considerations: Caustic embrittlement has not been encountered as yet in high-pressure boilers; and many operators of high-pressure boilers find it impossible to maintain those ratios without inducing foaming and subsequent carry-over.

A review of operating experience has indicated that, in general, it has been found that where the maintenance of this ratio has been attempted such a high concentration of dissolved solids in the water has resulted that it was impossible to operate without violent carry-over. As a result, the ratios in most cases were not maintained. Necessity has demanded operation in a manner contrary to accepted rules, yet no dire effects have been the result. A number of explanations may be offered. Among these are the welded construction of these high-pressure units, which precludes the possibility of seams and crevices in which boiler water may concentrate to such values as from 50,000 to 100,000 ppm of sodium hydroxide necessary to induce intercrystalline corrosion, a factor in the development of caustic embrittlement. Another reason may be related to the findings of the recent research efforts at the United States Bureau of Mines and at the University of Illinois wherein it has been indicated that the A.S.M.E. ratios are not, under all conditions, adequate to stop this type of cracking and therefore the factors that cause embrittlement are not those which are uniformly combated by this salt as has heretofore been generally believed. Stress relieving also reduced the possibility of highly stressed metal, another necessary factor in the development of this phenomenon. Regardless of what the real reason

may be, there is a great deal of operating experience that indicates no evidence of embrittlement under high-pressure conditions where the ratios are not maintained. A subcommittee of chemists, functioning under the A.S.M.E. Boiler Code Committee, is at present reviewing operating data and relating it to the recent findings of research on this subject in an effort to modify the code recommendations in order to bring them in line with our present knowledge.

It would be possible to devote many pages to a discussion of the various phases of this embrittlement research, but that is only one phase of feedwater treatment and these have been published in detail by both Dr. Schroeder and Professor Straub and may be reviewed at will in the trade journals or society publications.

SUMMARY

The objectives of boiler-feedwater treatment have been enumerated, and it has been indicated that with the advent of higher-pressure operation these have not changed. Only their importance and significance in relation to desired efficiencies have changed. These changes have served to place more emphasis on the accuracy and intelligence with which feedwater treatment and problems related to it are attacked. In the treatment of water for high-pressure boilers rule-of-thumb methods must be discarded, and the problem placed in the hands of thoroughly experienced and competent chemists who can apply the laws of chemistry and chemical reactions to a problem now requiring highest skill and most precise manipulation.

The processes of treatment now available to the industry have been discussed, and it has been pointed out that the process by which all of the objectives of boiler-water conditioning may be attained involve, in general, no simple method of treatment; but that several methods or portions of those methods must be intelligently combined to produce a complete system of treatment. Moreover, it has been indicated that the adoption of a complex process is not necessarily permanent in any specific case but that even this must be changed as conditions of operation or changes in the feedwater system occur.

The important subject of caustic embrittlement and its prevention has been mentioned, and it has been indicated that the formerly accepted methods of prevention have been found to be sometimes unreliable in their application. The progress of research on this subject has been rapid and new preventive measures are now under observation in service. It is hoped that there will soon be available to the industry a solution to the problem, rational in the light of the available facts, and that this problem will soon be regarded as just another problem which the joint efforts of industrial research have helped to solve.

BIBLIOGRAPHY

1 "Boiler Operation as It Affects Prime Movers," by S. E. Tray, MECHANICAL ENGINEERING, vol. 60, 1938, p. 475.

2 "Behavior of Sodium Sulphite in High-Pressure Steam Boilers," by R. M. Hitchens and J. W. Purssell, Jr., Transactions A.S.M.E., vol. 60, 1938, p. 469.

3 "Decomposition of Sodium-Sulphite Solutions at Elevated Temperatures," by W. O. Taff, H. F. Johnstone, and F. G. Straub, Transactions A.S.M.E., vol. 60, 1938, p. 261.

4 "Attack on Steel in High-Capacity Boilers as a Result of Overheating Due to Steam Blanketing," by R. E. Hall and E. P. Partridge, Transactions A.S.M.E., vol. 61, 1939, p. 597.

5 "Solid Matter in Boiler Water Foaming," by C. W. Foulk and R. Ulmer, *Industrial and Engineering Chemistry*, vol. 30, 1938, p. 158.

6 "The Cause and Prevention of Steam-Turbine-Blade Deposits," by F. G. Straub, Engineering Experiment Station, University of Illinois, Urbana, Ill., Bulletin No. 282, p. 30.

30,000 Engineering Positions Have Been Filled

(*Continued from page 391*)

E.S.E.S. is seeking positions, as well as qualified applicants. Individual members could be extremely helpful in notifying the Service of opportunities available which come to their attention and referring to the Service members and nonmembers seeking new connections. Obviously, the more inquiries and registrants from outside the districts in which the present three offices operate so effectively, the better will be the results to the employer, the employee, and to the engineering profession as a whole.

Even after a member has registered with the Service, his cooperation is still needed. He should immediately notify the Service of any change in his status, such as change in address, no longer available, or willingness to consider an opportunity at more or less salary than he stated in his original application. If notified of a position by the Service, he should acknowledge it immediately. He should not condemn the Service because of the fact that it has not been able to place him. In many cases much of the fault is with the individual himself. It must also be realized that the Service cannot create opportunities when none exist. Many applicants have registered with the Service on several occasions before they were able to locate a position through its efforts, others have found a position the same day they registered, while still others have been registered up to several years before finding exactly the type of work they desired. The good will and support of every member is needed, but unfortunately in employment work nothing further is heard from the successful applicant or the satisfied employer since that is what is expected of the Service, but where the reverse condition is true condemnation of the Service is usually long and loud. However, as to actual results, the all-time placement record of almost 46 per cent of all positions received being filled, speaks very well for itself as compared with any other agency in existence, commercial or otherwise.

In order that the Service may best serve all parties concerned, it is absolutely necessary that there be maintained in the files only the records of engineers who are actively interested in securing employment, or those who are endeavoring to better their present positions. It has been found necessary, owing to the rapid accumulation of records and the necessity for knowing whether applicants are active, to make inactive any record that does not indicate that the man has made a personal call, telephone call, or mailed a notice for a period of six months.

CONCLUSION

In conclusion, it is again emphasized that the Engineering Societies Employment Service is ready to serve individual engineers and the engineering profession as a whole in the development of better engineering employment relations. To the member it offers a friendly, confidential, and specialized plan of securing a position. To employers, whether members or not, it offers a wide selection of properly trained and qualified engineers to fill their every need.

A PERSONNEL PROGRAM FOR A SMALL PLANT

By HAROLD B. BERGEN

McKINSEY & COMPANY, NEW YORK, N. Y.

EVERY plant, no matter how small, has personnel problems to solve, although they may not be recognized as such. For example, the small plant as well as the large unit has the problem of selecting new employees with desirable qualifications. These employees must be trained to do their work efficiently and safely. When higher openings occur, some employees must be selected for promotion. When the work fluctuates in various departments, some employees must be transferred. When work schedules are cut, some employees must be laid off; and some must be re-employed when production schedules are increased. At times it is necessary to discharge some employees because of inefficiency or for other cause.

In addition to breaking in new employees, a small plant must train those employees who are transferred or promoted to other positions. When new processes or equipment are introduced, the employees affected must be kept abreast of these new developments. Furthermore, in order to keep ahead of competition, a small plant must continually simplify its operations and improve the performance of all employees.

Not only must employees be trained, but also they may require some education in essential facts about the company. This may be an important personnel problem to be solved, because, no matter how small the plant, the workers may be subjected to misinformation from the outside about company earnings, executive salaries, "capital, management, and labor," economic fundamentals, business conditions, and the like.

Proper selection and training are only beginning steps in good employee relations. It is necessary, also, for a small plant to establish equitable rates of pay and to eliminate wage inequalities. In order to call forth the best efforts of these employees, their pay should be commensurate with the relative importance of their jobs and their performance as individuals in these jobs. Much dissatisfaction and inefficiency is often caused by wage inequalities within the plant.

Even if the employees are selected, trained, and compensated properly, the small plant, because of the necessity of reducing costs, must prevent accidents and protect the health of its workers. Absenteeism and labor turnover due to sickness indirectly increase costs to an extent not usually appreciated by the management. Chronic diseases decrease employee efficiency and increase production costs. The indirect costs of accidents are approximately four times the direct expenses of workmen's compensation and medical treatment.

In addition to these problems, the small plant as well as the large has the problem of complying with social-security legislation with a minimum of expense and disruption of operations. Company benefits, if any, must be coordinated with federal old-age payments, state unemployment compensation, and workmen's compensation. The superannuated and permanently disabled employees must be separated from the pay roll by just but not harsh means. The temporarily disabled employee, even though his disability may be nonoccupational, must receive consideration. Also, the death of an employee from illness or injury necessitates some protection for his family.

Compliance with the National Labor Relations Act and the Fair Labor Standards Act presents a number of other personnel problems to the small plant. The unintentional violation of either of these acts may prove to be exceedingly costly. State labor legislation must also be complied with.

As long as workers and executives remain human beings there are bound to be complaints and grievances even in the smallest plants. The discovery and adjustment of these grievances before they become serious is an important personnel problem which must be solved.

If the plant is nonunion, there is always the contingent problem of a unionization drive and union recognition. On the other hand, if one or more unions have been recognized, there is the recurring problem of collective bargaining and of operating satisfactorily under a collective agreement.

Small plants as well as large units have discovered that it pays to stabilize employment as much as possible. This is a major problem which all managements must face. Aside from its direct effect on manufacturing costs, employment stabilization should be related to merit rating in state unemployment compensation laws and to the overtime provisions of the Wage and Hour Act.

WHAT SHOULD A SMALL PLANT DO ABOUT SOLVING THESE PERSONNEL PROBLEMS?

An organized approach to these problems in a small plant should pay dividends in terms of improved employee morale and efficiency, lower costs, and higher long-range net profits. Also, an organized program is effective insurance against costly labor disputes. The possibilities of increasing long-range net profits by means of organized personnel management, however, have infrequently been appreciated by the managers of small plants. The reasons for this should be obvious—the direct effects of unorganized versus organized personnel administration can rarely be isolated in the cost statement. Consequently, management hesitates to spend time, effort, and money for projects on which it cannot be guaranteed an immediate and satisfactory return.

It is difficult, therefore, to convince the manager of a small plant that preventive work is much more economical than emergency repair measures. As a result, he waits until he has accidents, spoiled work, high labor costs, labor disputes, and the like, and then attempts to solve these emergencies by "trouble shooting." On the other hand, he will often spend money for time studies, wage-incentive plans, and speed-up systems, because he can measure the immediate effects of these projects in the cost statement, and because he does not realize that a systematic long-range personnel program would in the long run be at least an equally effective means of improving his competitive position and increasing company earnings.

Contributed by the Management Division for presentation at the Spring Meeting, Worcester, Mass., May 1–3, 1940, of The American Society of Mechanical Engineers.

WHAT PRACTICAL STEPS IN PERSONNEL ADMINISTRATION SHOULD BE TAKEN BY THE SMALL PLANT?

The first step in a sound, long-range personnel program in a small plant is a conviction on the part of the chief executive that such a program will pay, a willingness on his part to give continuous direction and support to the program, and an appreciation of the difficulties of evaluating its benefits directly by means of the cost statement. In other words, the head of the company must "get religion" if the program is to be a success. Without this, any personnel program will be spotty and ineffective.

The next step is to impress upon the other executives and supervisors that they are responsible for satisfactory employee relations in their respective units. Anyone who supervises the work of one or more individuals is responsible for sound personnel administration and, unless he is the exceptional individual, must be trained to discharge this responsibility effectively. This is in itself a large order, because rarely will an executive or supervisor admit that he is not proficient in sizing up and handling men. The personnel program, therefore, should be developed in consultation with the supervisors who will be required to administer it, and systematic training should be given these individuals.

Another important step in developing a personnel program in a small plant is to consult with the employees who will be vitally affected by it. H. H. Carey, of the Western Electric Company, has suggested that this process be called "consultative supervision," which means that the employees or their representatives are consulted as equals on all matters affecting the employees' welfare or interests prior to formulating policies or taking action. If the plant has satisfactory contractual relations with a union, it may be good strategy to consult it before changes are made in personnel practices. On the other hand, if the plant has not been unionized, the management should discuss proposed changes directly with the employees. The small plant has a distinct advantage over the larger unit, because the top management can establish closer personal relationships with the employees.

There is an additional step which a small plant should take. Although the chief executive of the company is by the nature of his position the chief personnel officer, he may, depending upon the size of the plant, need specialized assistance in developing and executing the personnel program, just as he needs specialized assistance in connection with production, sales, purchasing, finance, and accounting. In a plant so small that the supervisory and executive staff consists of only three or four individuals, such specialized assistance would obviously be uneconomical. In such a company, the chief executive is likely to be, in addition to general manager, a combination plant superintendent, sales manager, purchasing agent, treasurer, comptroller, and personnel manager.

The plant with approximately one hundred employees or more, however, should consider the desirability of assigning to one executive the responsibility of assisting the president in planning and coordinating the personnel program. The size of the plant obviously will determine whether this is a part-time or full-time job. A number of progressive plants, with enrollments of approximately two hundred employees each, have found it desirable to appoint a full-time personnel manager and to supplement this position with a part-time medical director and a full-time registered nurse. In addition to her customary duties, the nurse is assigned other personnel responsibilities, including the keeping of employment records, social-security records, pay-roll records, and the like. The amount of time that the industrial physician should spend in such a plant will vary, of course, with the nature of its processes, its location, and the number of employees.

The personnel manager should give continuous and specialized study to problems of employee relations, should recommend to the president the personnel policies and procedures to be established, should assist all executives and supervisors in discharging their responsibilities for personnel administration, should keep in close touch with the attitudes of employees toward the personnel practices of the plant and toward the supervision, and should be responsible for maintaining the essential personnel records.

The small plant will find the foregoing organization for personnel administration both practical and economical. Through this organization it will be possible to develop sound personnel policies and procedures which are essential parts of an organized program. These standards should be put in writing, so that the employees and supervisors will understand clearly just what the plant stands for in employee relations.

WHAT PHYSICAL FACILITIES ARE NEEDED FOR SOUND PERSONNEL ADMINISTRATION?

Before developing standard personnel policies and procedures, it will be desirable for the small plant to provide the necessary physical facilities for personnel administration. An employment office should be provided in which interviews can be carefully conducted without interruption and without the presence of a third person. An adequate waiting room for applicants should also be provided, because applicants forced to stand in line outdoors become resentful, especially if the weather is inclement.

Also, there should be adequate dispensary and hospital facilities to provide for proper physical examinations and to assure efficient care of the ill and injured. The Committee on Healthful Working Conditions of the National Association of Manufacturers recommends approximately 125 sq ft for dispensary space in a plant employing 200 workers or less, and 300 sq ft in one employing 200 to 300. The American College of Surgeons recommends a minimum of three rooms, consisting of a waiting room, a treatment room, and a room for consultation or for making physical examinations. This problem, of course, requires individual consideration in each plant.

In addition, there should be a room available for supervisory training conferences, in which there should be a large table which the supervisors can sit around, put their feet under, and write on. This room should be free from noise as well as other interruptions, and comfortable chairs should be provided.

WHAT PRACTICAL PERSONNEL POLICIES AND PROCEDURES SHOULD BE ESTABLISHED IN A SMALL PLANT?

One of the first steps to be taken in developing sound personnel policies and procedures should be finding out what the employees think of present practices, of their job relationships, of the supervision, and of the company. In doing this, it is not necessary for a small plant to use the techniques of attitude measurement which have been utilized in some of the larger factories. A frank and confidential interview with each employee by the personnel manager should yield much valuable information which will be helpful in planning definite personnel policies and practices. It will require considerable skill on the part of the interviewer, however, to convince the individual employee that the management is really interested in finding out what is on his mind, regardless of how antagonistic this attitude may be. There must, of course, be a scrupulous adherence to a promise of anonymity. The sincerity and personality of the interviewer will determine his success in winning the confidence of each employee and of ascertaining what the workers actually are thinking. If this is done, however, the management will have invaluable facts at its disposal as

the basis for intelligent planning of improved employee relations.

Great care should be exercised in selecting employees for initial employment. The preliminary selection should be made in the employment office by the personnel manager. The employment interview should be comprehensive and unhurried. A properly designed application blank should be filled out by desirable applicants. A painstaking investigation should be made of the previous business history of each applicant seriously considered for employment. The final selection should be made by the foreman of the unit in which the applicant is to be placed. In the case of skilled jobs, it will be desirable for a third interviewer to pass on the qualifications of the applicant. Experience has proved that the approval of each applicant independently by three interviewers increases tremendously the accuracy of the selection procedure.

Before an applicant is placed in his new work, he should be given a pre-employment physical examination in order to prevent any unnecessary costs and misunderstandings which result from the acceptance of poor physical risks and to eliminate applicants who would, if employed, be menaces to themselves, to other employees, and to company equipment and materials.

It will be helpful in the selecting of new employees, if the personnel manager will assist the foremen in preparing specifications for each class of positions in the plant, which will define the physical, mental, and experience requirements of each class of work.

Closely related to the selection of new employees are the procedures for transfer, promotion, demotion, layoff and re-employment, discharge, and resignation. All changes in an employee's status should clear through the employment office. Vacancies in the better jobs should be filled by promotion whenever there are employees who can qualify under appropriate standards. In this connection, it will be desirable for each foreman to rate periodically the progress of each of his employees and for the employment office to maintain an adequate yet concise qualification and service record of each worker.

Relative qualifications and merit should be the basis for layoffs and re-employment but, if these factors are relatively equal, length of service should govern. Due consideration should also be given to family status and need. Whenever practicable, advance notice should be given to employees who are to be laid off. It is unwise to adopt any rigid or complicated seniority formula, because it is difficult to write one which will be equitable to all employees in the light of changing conditions. It is desirable to depend upon good personnel administration rather than on legalistic regulations in handling such problems. The small plant should keep this in mind, when and if it is required to negotiate a collective agreement with one or more unions.

Discharges should be handled with great care. Except in cases of flagrant insubordination or the like, the foreman should consult the employment office before discharging an employee. If feasible, the employee should be given an opportunity in another job, and final separation should not be effected without adequate warning. Each employee terminated should be interviewed in the employment office with a view to convincing him, if possible, of the justice of the discharge and to making him a friend of the company in spite of this action. Employees who are resigning should also be interviewed to try to find out the real reasons for their leaving and to take corrective steps if possible. It would be desirable for the plant manager also to interview each employee who is being discharged.

Systematic training should be given each new employee, each employee transferred or promoted to another job, and all employees affected by changes in equipment and processes. Selected employees may be "earmarked" and given special training for promotion. Employment stabilization will be facilitated if a number of employees are trained for two or more jobs so that they can be transferred between departments when the volume of work fluctuates. Employees should be encouraged also to make suggestions for improvements in tools, machinery, and procedures. This training of employees is a responsibility of the foreman, and he should, therefore, be given coaching in how to train.

It will be desirable also to educate all employees in essential facts about the company, its earnings, and economic fundamentals. Many misunderstandings are due to misinformation from outside sources or to lack of information from the management. The manager of a small plant should meet occasionally with the employees and discuss company information of interest to them, but he should first cover this material with the foremen. This procedure can be supplemented by written information distributed in mimeographed form. Great care should be taken, however, to avoid propaganda and to stick to facts.

The training of employees, however, should start with the training of the foremen. They should participate, as indicated previously, in the establishing of personnel policies and procedures. They should truly be made a part of management. They should not be short-circuited. They should be paid on a salary basis. They should be trained in how to train and in how to solve personnel problems under present-day conditions. It should be remembered that the foreman in a small plant often has been appointed because of long service or because of skill as manual worker, with little consideration of his potential supervisory ability. He has been expected to develop leadership skill by some mysterious process of "absorption." In a small plant, in addition to coaching on the job, one of the most practical methods of foreman training is the holding of carefully planned conferences led by the chief executive.

Systematic foreman training presupposes the careful selection of foremen, which has not usually been the practice in the past. The small plant should select its foremen on the basis of critical standards and appoint only men who appear to have potential capacity for leadership and adjustment to present-day conditions.

The pay for each position in the plant should be determined on the basis of its relative grade. A grading plan should be developed, therefore, which will group all classes of jobs into grades arranged in an ascending order of importance. This grading will be found helpful also in making transfers and promotions. Depending upon the financial status and competitive position of the company, the wages for each grade of work should be at least equal to the wage levels for similar work and conditions in the community. An appropriate adjustment should be made in pay whenever an employee is transferred to work of higher or lower grade.

Whenever fair standards of performance can be properly established, which are acceptable to the employees affected, wage-incentive plans may be superimposed on the basic pay schedules. The acid test of such plans, however, is whether they appeal to the foremen and employees as being fair. Changes should not be made in work standards without consultation with the foremen and employees concerned. Complicated wage-incentive plans which are hard to understand have no place in a sound program of personnel management.

SAFETY AND HEALTH ACTIVITIES

Safety and health activities should include not only the pre-employment physical examination but also periodic re-examinations of each employee and examinations of employees re-

turning to work after absenteeism due to illness or injury. The medical director should cooperate in the prevention of industrial accidents and occupational diseases. Good working conditions should be maintained, and special attention should be given to problems of temperature, humidity, ventilation, lighting, noise, heavy labor, and the like. Adequate safety devices should be maintained, systematic safety inspections should be made, and all employees trained by their foreman in safe practices. Careful attention should be given to plant sanitation, including cleanliness of rooms and lockers, water supply, and sewage and garbage disposal.

All industrial injuries and occupational diseases should receive efficient care. The unsupervised use of first-aid kits, however, should not be permitted. Reasonable first aid and advice should be given employees suffering from nonindustrial injuries and illnesses, but they should be referred to their own physicians for further diagnosis and treatment. Preventive health and safety measures of this type will prove much more economical and effective than merely having a physician on call for emergency repair measures.

Problems of employee security are usually vexing in a small plant. Formal death and disability benefits will prove to be more satisfactory and economical than "passing the hat" and considering each case "on its merits." Workmen's compensation awards should be related to disability benefits in cases of occupational disabilities. State unemployment compensation benefits should be related to any plan for dismissal compensation or unemployment benefits that the small plant may wish to establish. Although federal old-age benefits will assist in solving problems of superannuation, they may not be adequate for all classes of employees. A small plant will find it desirable and economical to study these problems of employee security and to develop plans which will provide, within the capacity of the company to pay, a measure of protection to all employees against the risks of death, disability, unemployment, and old age.

Prevention of unemployment, however, is one of the most profitable personnel projects that the small plant can undertake. Consideration must be given to the desirability of paying overtime (according to the provisions of the Wage and Hour Act) during busy periods, in comparison with the cost of unemployment-compensation taxes for the turnover of temporary employees (according to merit-rating provisions in state laws). Much can be done to stabilize employment by forecasting sales, coordinating sales with production, scheduling repairs and maintenance for dull periods, planning the installation of labor-saving machinery well in advance, training employees in versatility and flexibility, developing new products and new uses for present products for off-seasons, and the like. Consideration should also be given to the desirability of working out with the employees a plan for stabilizing earnings, so that extra earnings during busy periods will be set aside in a fund to be drawn upon during slack periods.

Even a small plant has grievances to adjust, men being what they are. If a grievance is not discovered and adjusted promptly by the management, there are two grievances—the original one and the complaint that the original grievance has not been adjusted. The systematic interviewing of employees in a small plant by a competent interviewer, discussed previously in this paper, will bring to light most of the grievances which may exist, as well as latent sources of complaint. In addition, a formal grievance procedure should be established so that any employee who has a complaint will feel free to discuss it with his foreman and, if a satisfactory adjustment is not made, to carry it to the top management without fear of jeopardizing his job. Most collective agreements with unions provide for such a procedure. The nonunion plant also should establish a satisfactory grievance procedure and should train its foremen in how to prevent grievances and how to adjust them.

COMPLIANCE WITH N.L.R.A. ESSENTIAL

Care should be taken to comply with the National Labor Relations Act. The foremen should be trained to refrain from doing or saying anything that could be construed as unfair labor practice, as defined by the act. In the event of a unionization drive the management should sincerely take the position that it is none of its business whether the employees join one union, several unions, or no unions. If there is any doubt in the employer's mind relative to the validity of a union's claim that it represents his employees, he should refer the matter to the labor board. If the board certifies a union as the representative of his employees, he should then bargain collectively with it in good faith. (It will not be feasible in this paper to discuss the policies and procedures for dealing with organized labor, except to state that sound personnel management should prevent any serious problems from arising.)

Needless to say, care should be taken also to observe the provisions of the Wage and Hour law and the administrative rulings which are issued from time to time by the Wage and Hour administrator. In addition, appropriate standards should be established relative to such matters as overtime pay, differentials in pay for evening and night shifts, Saturday, Sunday, and holiday work, vacations, time off for personal emergencies, leaves of absences, military and jury duty, and the like. Inequalities in these matters between individuals and departments usually cause grievances. It should be kept in mind also that vacations with pay for plant employees are rapidly becoming accepted practice in American industry. The standards to be established, however, will vary with the conditions in the community and the financial position of the company. In any event, definite standards should be established and made known to the employees, so that misunderstandings and grievances will not arise when the standards are applied to individual cases.

It should be emphasized that successful personnel management will require the maintenance of adequate and concise records covering employee qualifications, service, earnings, quantity and quality of work, attendance and punctuality, ratings of progress, accidents and illnesses, and the like. In addition to records of outstanding accomplishments and suggestions, notations should be made of reprimands and warnings, because these may prove helpful in connection with any charges of unfair labor practice which may be made against management.

CONCLUSION

The program suggested in this paper may at first glance seem to be too extensive for a small plant. However, it is nothing more than a systematic way of doing the things that the small employer must do anyhow. As indicated previously, a preventive program is always much more effective and less costly than emergency repair measures. It means that a smaller amount of money would be spent in advance than would be spent later if a sound personnel program were not carefully planned. The consistent application of such a program in a small plant should definitely pay in terms of increased net profits over a period of from two to three years. If the employer will sit down and estimate fully all of the indirect costs involved in employee relations and the savings obtainable by organized personnel management, he should be able to convince himself of the desirability of such a program. He should also look at it from the standpoint of insurance against future labor difficulties. No one ever hears of serious labor difficulties in a small plant with a sound personnel program.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

SPEAKING as the first guest lecturer of the Powder Metallurgy Laboratory, Stevens Institute of Technology, on the evening of April 2, Dr. Clarence W. Balke warned his audience that the strength and hardness figures he quoted applied only to the particular specimen of hard carbide whose photomicrograph he was showing. Where so many variables were involved he pointed out, generalization was dangerous. Even dust scattered accidentally into a mixture of powders might cause voids in a finished hard-carbide product and render it useless for its intended purpose, for on such trifles rests the fate of man's endeavors.

This capacity for infinite variety in nature is at once a source of wealth and a source of waste. Too much seasoning may spoil the broth, too little make it flat. It is the superior cook who knows what is just right and whether it is the salt or garlic that is at fault. The foolish cook pours the mess into the sink; the wise one adds the needed seasoning and bears the bowl in triumph to the table.

For several years the tasters of our economic and social broth have found it either flat or too highly seasoned. Seeking to remedy the faults the cooks have been fooling around with their herb jars. Some have tried to throw out broth and pot together and treat the impatient guests to new and untried concoctions. Only let a pinch of the right condiment be added to the wholesome broth with its familiar ingredients and the economic feast will go forward.

Readers of business statistics at home have been aware that the cooks have been dipping into the wrong spice jar, for the curves have been tending downward for several months. They are also aware of the fact that if the right proportions are not hit upon soon the amateur cooks will prevail, throw the broth down the sink, and substitute the dessert for the soup course. Abroad, the devil's caldron of war is boiling over, to spread how far, no one knows.

Research workers, to get back to Dr. Balke, have to substitute intelligence for experience in their concoctions. They too run the risk of throwing out their failures and abandoning a fruitful line of investigation just because apparently insignificant deviations from the correct formula make astounding differences in the hoped-for results. No one can guess how many failures have been just short of success; the proper balance destroyed by an apparently insignificant deviation; a wrong trail followed to a fruitless conclusion because of hasty generalization. A hair perhaps divides the false from true, failure from success, waste from wealth.

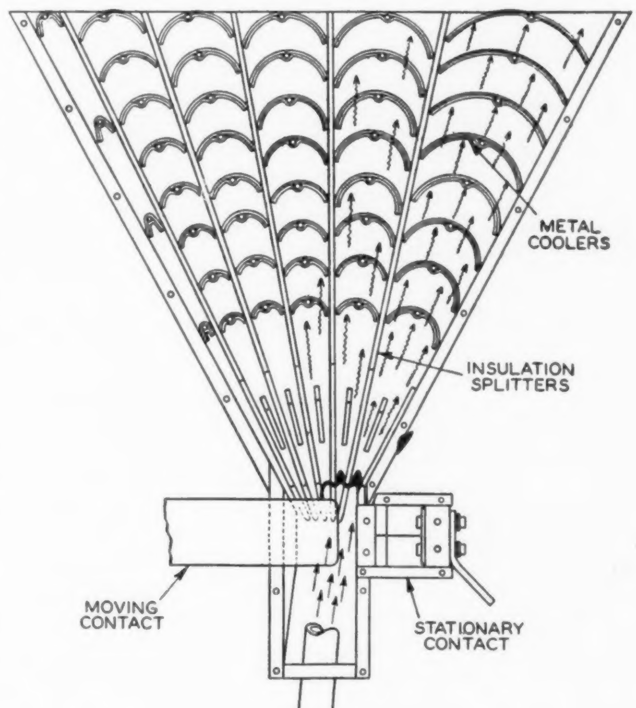
Coincidentally in Washington occurred the sesquicentennial of the U. S. Patent system and the beginning of a phase of the TNEC inquiry that is designed to develop information on the broad subject of technological change and its effect on production and employment.

Engineering Foundation

A quarter of a century ago Ambrose Swasey, honorary member and past-president of The American Society of Mechanical Engineers, gave engineering research a powerful impetus by setting up the Engineering Foundation with an initial gift of \$200,000, subsequently increased by four other gifts to \$818,600. Gifts by others, including Edward Dean Adams, Henry R. Towne, W. S. Barstow, and Sophie M. Gondron, have swelled this sum to \$990,000, the book value of the fund on September 30, 1939.

Early this year the Foundation commemorated its 25 years of service "for the furtherance of research in science and engineering or for the advancement in any other manner of the profession of engineering and the good of mankind" by issuing a 76-page report, with appended tables, reviewing its history and accomplishments.

A considerable portion of the report is devoted to brief ac-



COMPRESSED AIR BLOWS OUT ELECTRIC ARC

(In order to lengthen the life of circuit breakers and to prevent fires caused sometimes by the electric arc when the switch is opened, Westinghouse engineers have developed an interrupting element which uses a cross blast of compressed air that passes between separated contacts in such a manner that the arc is driven against insulating splitter plates, where it is elongated, reduced in cross section, and finally broken. During a recent demonstration, a compressed-air circuit breaker of this type was tested successfully on power interruptions ranging from the opening of normal-load current of 2000 amp at 13,200 v to the three-phase, 1,500,000-kva short circuit capacity of the high-power laboratory.)

counts of the major projects it has assisted. These accounts are accompanied by quoted comments of persons who have been close enough to the projects to appraise their significance and value. The showing is impressive and the projects cover a wide field of interest. Under mechanical engineering, for example, may be found résumés of familiar projects, such as those relating to the thermal properties of steam, lubrication, strength of gear teeth, fluid flow, fluid meters, cutting fluids for metals, wire rope, effect of temperature on properties of metals, critical-pressure steam boilers, cottonseed processing, boiler feedwater, cutting of metals, mechanical springs, and plasticity of metals.

In addition to projects in mechanical engineering, others of general interest, in civil engineering, in mining and metallurgical engineering, in electrical engineering, in welding, and in engineering education are similarly reviewed with testimony as to their importance.

Statistics of all of the projects, 73 in number, are tabulated. A summation shows that for these projects the Engineering Foundation made grants of $411,025. These grants were augmented by contributions to the Foundation of $466,637, by engineering society appropriations of $51,395, by other contributions of $563,461, by contributions in kind of $214,232, and by labor of an estimated value of $189,634 and supervision of estimated value of $1,215,350, making a total of $3,111,734. Expressed in other terms, a grant by the Foundation of $1 resulted in an expenditure of $7.57 on a project. This demonstrates the contention of the Foundation's director, Otis E. Hovey, that the Foundation is a "catalyst."

The report "Twenty-Five Years of Service" affords a convenient review of the work of the Foundation that is brief but comprehensive. If one were to find fault with it, it would be on the ground that an inadequate amount of space, $1^1/_2$ pages, has been devoted to "increasing needs for research." The Foundation has left it largely to the imagination of the reader, stimulated by the record of accomplishment, to engender enthusiasm for greater service in the future and to visualize what this service may be and how it can be extended.

Mellanby

On March 15, 1940, Prof. A. L. Mellanby, member A.S.M.E. and honorary member of The Institution of Mechanical Engineers, delivered the twelfth Thomas Lowe Gray Lecture, "Fifty Years of Marine Engineering." Professor Mellanby's lecture material is drawn from his own active life in marine engineering and from papers before engineering societies in Great Britain that deal with advances in the art. The paper constitutes a readable summary of marine-engineering progress in the world's greatest maritime nation. The method followed in the paper is described by the author as follows:

> It has for long been my opinion that the greater number of all improvements in engineering practice have been due to the application of scientific principles to design and manufacture, and that to a great and often unappreciated extent both experimental and analytical research have contributed to the initiation and appreciation of these principles. Often, owing to the long time that has elapsed between the discovery and the application of some new principle, the origin of the idea and the identity of the discoverer have become obscure and the credit for any advance has frequently been given to him who had the quickness of vision necessary to see the value of the application. I am proposing therefore to develop this lecture by telling you something of the work of the men who were first responsible for the step-by-step advances, and thus to preserve some record of their influence upon progress in a manner which makes appreciation more easy than does the continual reference to the proceedings of different scientific institutions.

The lecture is a useful addition to engineering history.

Unwin

A report of the Unwin Memorial Committee appears in the March 1, 1940, issue of *Engineering* over the signature of Sir Alfred Chatterton, chairman of the committee.

It will be recalled that representatives of The American Society of Mechanical Engineers on the fund-raising committee were Ambrose Swasey, deceased, who acted as honorary chairman of the A.S.M.E. group, and John A. Goff and R. E. W. Harrison. The American Society of Civil Engineers and the Engineering Institute of Canada also appointed representatives, and the report referred to acknowledges a contribution of £100 from the engineers of the United States and Canada.

The Unwin Memorial Committee was constituted in February, 1935, at a meeting held at the Institution of Civil Engineers, at which were represented the leading technical institutions, the colleges with which he had been connected, former students, and others interested in commemorating the life and work of the late Dr. W. C. Unwin, F.R.S. It was decided that the principal objects to be aimed at were the raising of a sum sufficient to enhance to a more useful scale the value of a small existing Unwin Scholarship at the City and Guilds College and the publication of a memoir, based on the special number of *The Central*, issued after Dr. Unwin's death.

In February, 1938, this committee was able to report to the Memorial Committee that the objects aimed at had been achieved. The latter, thereupon, at a meeting held in the same month, decided that the fund should be made over in due course to the City and Guilds of London Institute, to be held in trust by that body to endow a scholarship at the City and Guilds College for a third-year student of that college desirous of continuing his studies for a fourth year. The amount originally asked for was £2500, and the gross amount received to date is £2949, 12s, 8d, of which £2703, 16s, 9d, was in the form of direct subscriptions.

The memoir, "The Life and Work of William Cawthorne Unwin," written for the committee by E. G. Walker, is an octavo volume of 254 pages, with 16 illustrations, and was published originally by the committee with a view to reducing expense. Owing to changes which took place subsequently, arrangements have now been made for the distribution of the memoir to be undertaken by George Allen and Unwin, Ltd., 40, Museum Street, London, W.C.1, who are now dealing entirely with the sale of the book.

Storer

The 1939 Lamme Medal of the American Institute of Electrical Engineers has been awarded to Norman W. Storer, retired consulting railway engineer, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., "for pioneering development and application of equipment for electrical traction." The medal and certificate will be presented to him at the annual Summer Convention of the Institute, which is to be held in Swampscott, Mass., June 24–28, 1940.

The Lamme Medal was founded as a result of a bequest of the late Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Company, who died on July 8, 1924.

Mr. Storer was employed by the Westinghouse Company from September 1, 1891, until his retirement October 1, 1936. An outline of his career issued by the A.I.E.E. says of his work:

> In 1904, the engineering department was reorganized and he was appointed engineer of the railway division, and thereafter devoted his entire time to electric transportation. This involved many excursions into uncharted fields such as those of single-phase and high-voltage direct-current railway electrifications, in both of which he did notable

work. He supervised the design of the original New Haven high-speed gearless passenger locomotives and several types of geared locomotives, all of which had to operate from either the 11,000-volt single-phase trolley or the 650-volt direct-current third rail. Here was developed the locomotive with each individual driving axle driven through springs carried on a quill around the axle to which a pair of twin motors was geared—a type which is generally used on most modern high-speed locomotives.

For operation from the single-phase trolley where heavy freight trains are handled on heavy grades, he pushed through the design of the motor-generator type of locomotive—a design which permits the use of direct-current motors and provides for voltage control and regenerative braking at all speeds.

In an effort to find the safe limit for direct-current voltage, he designed and built a quadruple equipment of twin motors and control for operation on a 5000-volt direct-current trolley. Two years of operation in commercial service in 1915–1917 showed only the best operating results and proved that nothing need be feared from 5000 volts direct current. Soon after the close of this test, an order was received from the C.M. and St.P.R.R. for ten large passenger locomotives over the Montana section of the line. This line was already in operation with 3000 volts direct current and these locomotives have been in satisfactory operation for twenty years. A few years later, Mr. Storer was in charge of the development of electrical equipment for oil-electric cars and locomotives.

Rays in Aircraft Defense

DISCOVERY (GREAT BRITAIN)

INFRARED rays are being utilized in the present war to detect enemy aircraft, according to an article by D. W. F. Mayer appearing in the March, 1940, *Discovery*, which ceases publication with this issue after twenty years of existence. These feeble heat rays, that are given out by an airplane engine, may be picked up by sensitive thermocouples and used to detect the presence of enemy aircraft. Such detectors have been in use for several years in astronomical observatories, for measuring the heat given out by stars and planets. So sensitive are these instruments that they can detect the heat of a candle at a distance of 50 miles. As infrared waves travel at 186,000 mps, compared with the 1080 fps of sound, heat waves from an airplane engine can be detected long before the sound of the engine is picked up by the most sensitive sound detector.

Experiments have been made with powerful beams of these invisible infrared rays, says Mr. Mayer, which can be directed into the sky and reflected back onto detectors by enemy airplanes. Further experiments have been made, chiefly in America, using infrared rays not only for detecting bombers, but also for destroying them. The heat rays given off by a bomber would be used to steer a small, unmanned airplane loaded with explosive. Such an aerial torpedo would follow the nearest bomber discharging hot exhaust gases.

Ice Prevention on Windshields

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

AS PART of its program of research intended to reduce the risks now attendant on airplane operation during icing conditions, the National Advisory Committee for Aeronautics has just completed an investigation of the prevention of ice on airplane windshields. Published as N.A.C.A. Technical Note No. 754, March, 1940, the report of the investigation carried out by Lewis A. Rodert states that vision through the windshield can be maintained during severe icing conditions by the use of heat. When put in operation prior to the formation of ice on the windshield, the rotating wiper blade prevents the formation of ice. A combination of heated air and a rotating wiper blade protects against the formation of ice on the windshield exterior, prevents frost on the interior, and provides for the removal of rainfall.

The apparatus for heating the windshield during the tests were of two types: The first was a panel in the windshield made of two panes of glass mounted in a frame and separated by a 0.25-in. gap. The gap contained electric heating wires which were surrounded by a liquid dielectric, ethylene glycol, to aid the transmission of heat from the wires to the glass and to prevent local overheating of the glass panes. In addition, a heating wire was enclosed within the rim of the panel. The second type, a heated-air panel, consisted of two safety-glass panes mounted in a frame and separated by a small air gap through which heated air from the airplane's cabin air heater was passed.

Three different types of drive were used for the rotating wiper blade. In the ice-prevention tests, an electric drive developed by the N.A.C.A. was used; the wiper blades were driven by a 50-watt electric motor through a flexible shaft at speeds varying from 300 to 750 rpm. In the rain-removal tests, two methods of driving the blade were used. One method was a drive from the airplane engine through a tachometer shaft and the other was through a commercially developed 90-watt electric motor permitting speeds up to 2100 rpm.

Airplane Heating Systems

SOCIETY OF AUTOMOTIVE ENGINEERS

THE heating system of a large air transport has an output which would be sufficient to heat an eight- to ten-room house in any kind of weather, stated W. W. Davies in his paper on "Passenger Comfort in Commercial Aviation," which was presented at the aeronautical meeting of the Society of Automotive Engineers, Washington, D. C., March 14–15, 1940. However, tied up with the problem of heating is that of ventilation. The present ventilating rate for a DC-3 airplane cabin is approximately one complete air change per minute. This change, which is much greater than the rate in houses and buildings, is necessary because tests have shown that the temperature within the cabin at any spot will not vary more than ±3 F. If the air is changed only once every two minutes temperatures at different points may vary as much as ± 10 F. Another reason for using the high ventilation rate is to eliminate infiltration of cold air from the outside through leaks, doors, and fuselage. The one-minute change provides each passenger with about 40 cu ft of air per min.

With such a high ventilation rate it is evident that the heating system must be of large capacity. Numerous tests have shown that 150,000 Btu per hr is required to heat a Douglas DC-3 airplane with one change of air per min at an altitude of 8000 ft and an outside air temperature of 0 F. A steam system is employed in this airplane in which a flash-type boiler is mounted in the tail stack of one of the engines. The reserve tank, pressure regulator, and other operating valves are mounted in the companionway for ready access by operating personnel. A standard finned-tube radiator is installed in the main air duct and the proper temperature of the cabin is obtained by adjusting a butterfly valve which mixes proper proportions of hot and cold air. Many designs have been tried and tests made of materials to improve on performance.

Another heating system used on airplanes is the hot-air type in which a shroud is placed over the exhaust stack. This is one of the simplest forms of heating systems and normally requires little maintenance. A few years ago some concern was ex-

pressed over the possibility of carbon monoxide escaping through the shroud and into the cabin and so the steam or liquid system appeared to take its place. Mr. Davies is of the opinion that with proper design of a hot-air exhaust manifold and the possible incorporation of one of the smaller CO indicators, it is possible that a suitable hot-air system can be used for commercial air transport, especially with stratosphere flying.

Several types of liquid heating systems have been designed using ethylene glycol or some similar liquid. The design normally uses a boiler or heater in the tail stack and radiator of standard design in the air duct. A controller or circulating pump is incorporated which controls the flow of liquid to the stack heater.

A particularly interesting development is one that is being jointly conducted by an aircraft manufacturer in collaboration with an automobile-accessories company to produce a self-contained heater or heating system that has a separate fuel supply and does not require operation of one or more of the airplane engines. Such a system will eliminate the necessity of portable air-heating units which are used at some airports at the present time to heat the airplanes prior to departure.

Fuel Bags for Airplanes

SOCIETY OF AUTOMOTIVE ENGINEERS

As a result of tests carried out by The Glenn L. Martin Company to find a substitute for the built-in fuel tanks of airplanes, a material consisting of grade-A airplane cloth impregnated and calendered with special coatings of neoprene on both sides was used in making a flexible, vibration-proof fuel bag or cell. The cell, which was described by F. J. Pepersack and C. E. Roberts at the aeronautical meeting of the Society of Automotive Engineers, Washington, D. C., March 14–15, 1940, has all stresses caused by the weight of gasoline taken up by the structure of the wing, fuselage, or float in which the cell may be housed. The interior of the cell housing must be relatively smooth and sharp corners must be avoided.

The dimensions of the completed cell are larger than the corresponding dimensions of the housing in which the cell is to be fitted. Sections of the cell are made to the desired shape and size and are joined together by a cemented lap joint reinforced by a double row of stitches. To prevent the stitches on the inside of the cell from coming in contact with gasoline, a thin neoprene cover is cemented over the stitches. Although the material has a high resistance against abrasion, all corners of the cell are reinforced on the outside with a small patch of the cell material for additional protection.

An access hole through which the cell may be installed or removed is provided in the housing, and a similar opening is incorporated in the cell. A conventional metal cover plate and inner flange assembly is used to attach the cell to the housing at this opening. At the fittings for vent, fuel outlet, filler, and fuel level gage, in a single cell and, in addition, at the interconnecting vent and fuel flow (limber) holes in the case of multiple cells, the cells are provided with neoprene-coated fabric reinforcements. By the installation of inner and outer metal fittings at these locations, the cell is clamped to the housing thereby accomplishing a seal and providing supports.

At the completion of all cementing and stitching, the cells are placed in an oven at an elevated temperature to effect a cure of the cement. The cells may be constructed as multiple units for installation between bulkheads incorporating openings sufficiently large for accessibility to all fittings from one access opening, or may be a series of single cells interconnected by vent and fuel-flow holes.

American Airlines Safety Record

CIVIL AERONAUTICS AUTHORITY

In contrast to the death and destruction caused by military aviation in Europe, the record of safety established by the 19 major air lines in the United States for the year ending March 26, 1940, is a gratifying aeronautical achievement. From the records of the Civil Aeronautics Authority, it is noted that the American air liners have flown in that period more than 2,000,000 passengers over a distance of 805,000,000 passenger-miles without a fatality to passengers or crew.

Many factors have made this record possible. Air-line pilots have steadily improved their flying technique. Cooperation between the men on the ground and the men in the air is better. A valuable factor has been a greater knowledge of weather and its influence upon flying. In the air-line shops, preventive maintenance has been rigidly adhered to. The air lines joined together and formed the Air Transport Association of America which is today a clearing house for information on maintenance, research, and operations.

Since its establishment in August, 1938, the Civil Aeronautics Authority has done much for air-line safety. It has greatly improved the physical equipment that aids air navigation, both in and out of the airplane. Airports are better, radio ranges and beacons are more efficient, air traffic control at airports is handled with less confusion, and regulations pertaining to air navigation are better.

At the same time that the C.A.A. was established, another organization came into being, the Air Safety Board. Although it works closely and harmoniously with the Authority, it is an independent board, controlling its own finances, and not responsible to the C.A.A. Its sole purpose is to improve safety in scheduled and nonscheduled flying. It does this by investigation, recommendation, and publication. Although it has no power of law enforcement and its recommendations may or may not be accepted by the C.A.A., the Board has earned the respect of the entire industry by its decisions.

Wire Stitching Steel

PRODUCT ENGINEERING

The same principle which is used in wire stitching paper sheets or periodicals is now being applied to cold-rolled steel sheets of 0.060 to 0.070 in. thickness and to soft metal in thicknesses up to 0.116 in. According to an article in *Product Engineering* for April, 1940, the method is applicable to joining operations done with rivets, screws, and glue. Wire stitching is at present being used in a wide variety of applications such as fastening insulation and tacking strips to steel automobile interiors, weatherstripping to windows, and antisqueak fabric to fenders. Variations in wire used, clinching pressure, and materials make mathematical calculation of the strength of steel-wire-stitched joints relatively impossible, but there is ample evidence that the stitch is at least as strong as the rivets ordinarily used.

A machine has been produced which is capable of driving steel wire through $^1/_{16}$ in. of steel at the rate of 285 stitches per minute, using a special high-tensile steel wire. In operation, the wire is fed through gear-driven feed rolls to a gripper which holds it in position until the cut-off die severs it to a predetermined length. After cutting, a mandrel carries the wire to formers which bend it to an inverted U shape; it is then driven downward by a ram toward the work, and is supported at top and sides by a wedge-shaped shoe. As the wire pierces the

work the shoe moves backward and is fully retracted by the time the staple is formed against the clincher.

Since assembly by steel stitching is relatively new, limitations and possibilities in its use cannot be clearly defined at the present time. Steels vary in physical characteristics, hence it is impossible to state as a general rule what total thickness of any given steel can be stitched unless actual tests are made on the material. As the action of the machine punches out a slug of the metal, the machine is most successful when stitching a nonmetallic material to steel since the slug can wander in soft material. When stitching heavy steel sheets together, it is recommended that a sandwich material of paper, cork, or rubber be placed between the sheets.

Forty Years of Power in England

THE INSTITUTION OF MECHANICAL ENGINEERS (GREAT BRITAIN)

A REVIEW of forty years' development in mechanical-engineering plant for power stations is given by Sir Leonard Pearce, engineer in chief, London Power Company, in a 61-page paper published in the February, 1940, Proceedings of The Institution of Mechanical Engineers. Presentation of the paper as the twenty-sixth annual Thomas Hawksley Lecture in November, 1939, was postponed owing to the outbreak of war. Besides a review of the progress achieved in the design and equipment of those stations with which the author has been associated, the paper summarizes the fundamental factors which have influenced the advancements made in the design and operation of these power stations.

Sir Leonard covers so many phases of steam-power development, including thermal efficiency, "topping," fuels, station layouts, turbines, speed, governing, boilers, and auxiliary equipment, that an abstract of the article in the space available could never cover adequately all the necessary points. Included in the paper are two large-size entropy charts, ten tables, and 60 illustrations.

Simplification of Boiler Design

THE INSTITUTION OF MECHANICAL ENGINEERS

FROM the theory of circulation of water and steam in water-tube boilers, as derived in a paper presented at a special meeting of The Institution of Mechanical Engineers in London, March 1, 1940, W. Y. Lewis and S. A. Robertson, the authors, conclude that, so far as circulation is concerned, the simple U tube will give satisfactory results over a wide range of pressures and rates of heating. Using the U-tube boiler shown in Fig. 1 as a standard of excellence, the performance of more complicated designs can be estimated, the effect of deviations from the standard studied, and guidance obtained in designing a boiler which is as near the standard as possible, provided that the downcomer in the standard U-tube boiler is not heated.

A study of the common variations from the U-tube standard shows that these departures from the standard frequently diminish the performance of the tube considerably, especially at the high furnace temperatures and working pressures now becoming common. However, a simplified form of boiler has been evolved which seems as near to the standard as possible, having unheated downcomers, individual water supply to each tube, free discharge for the steam, and ample circulation under natural head, for a wide range of pressures and intensities of heating. A simplified diagram of this type of boiler is shown in Fig. 2. Moreover, numerous external advantages accrue from the use of this rational design, such as freedom from longitudinal temperature stresses; ease of soot cleaning; ease of arranging the correct area of gas passages; considerable reduction in size and complexity by the elimination of bottom drums and headers; over-all reduction in size owing to the possibility

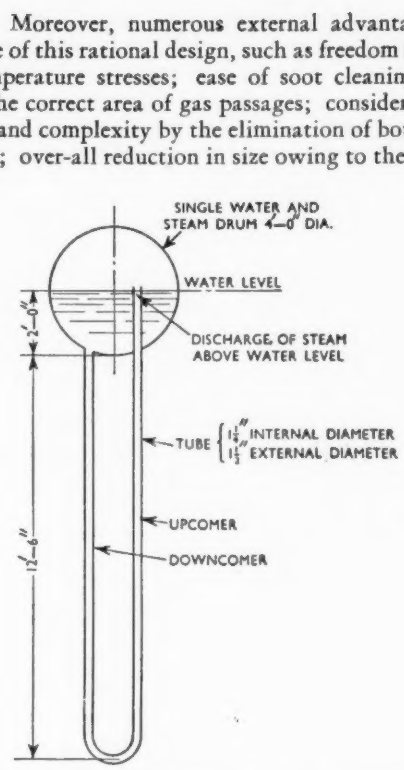


FIG. 1 PROPOSED STANDARD U-TUBE BOILER

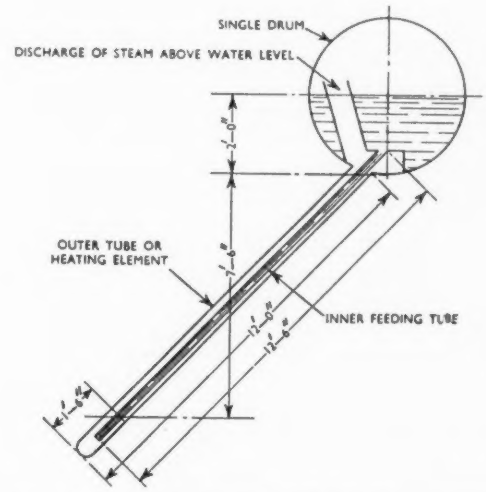


FIG. 2 MODIFICATION OF STANDARD U-TUBE BOILER

of using more intense heating rates with safety, especially in the rear tubes; and the great economies due to eliminating the need for an external economizer.

In a boiler consisting of several such tubes attached to the same drum, every tube forms an individual heating unit, with its circulation independent of the flow in any other tube. Each tube has its own individual supply of water through its own inner tube. The inner downcomer tube is unheated, and the annulus upcomer discharges its steam above the water level in the trough. The steam on reaching the upper part of the drum strikes suitable baffles, to make the water content separate out and to insure that only clean and dried steam passes to the engine or turbine.

A recently completed design of a portable boiler for A.R.P. duties (Fig. 3) shows the great economies in weight, space, and

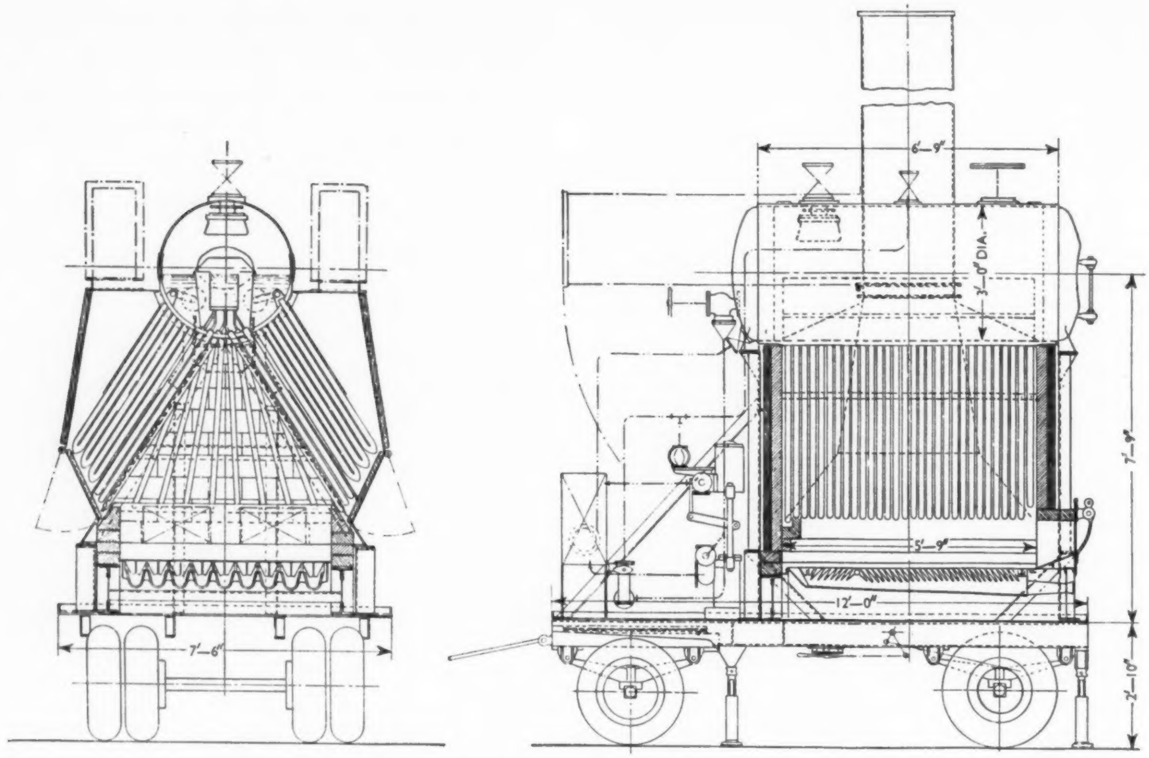


FIG. 3 LEWIS MOBILE SINGLE-DRUM WATER-TUBE BOILER

cost of boilers using tubes of the type described. This boiler, having a capacity of 600 lb of steam per hr at 185 psi pressure when hand fired with coal under low natural draft, is compact enough to be mounted on a four-wheel trailer; its total weight, including feed pumps and other auxiliary equipment, is less than 10 tons.

In conclusion, the authors claim that this form of water-tube boiler would appear to be a valuable advance in boiler technique, and to afford the best means for increasing safety and reducing the capital and maintenance and housing costs of boiler plant; of reducing boiler weight, work, and space on ships; and of improving reliability by reducing the frequency and duration of shut-down periods for cleaning and repairs, especially in base-load electric power stations.

Vinyon

AMERICAN DYESTUFF REPORTER

SIMILAR in some ways to Nylon, a new textile fiber, called Vinyon, is now being made from coke, lime, water, and salt, according to F. Bonnet, American Viscose Corporation, in a paper published in the March 4, 1940, issue of the *American Dyestuff Reporter*. Vinyon is produced by the polymerization of two well-known plastics, vinyl chloride and vinyl acetate. The former is a rubber-like material which can be molded or pressed into any desired shape, such as sheets, rods, tubes, and belts to take the place of rubber ones. The latter plastic easily wets or clings to surfaces, acting as an excellent bonding material. In fact it is used as a binder in composition wood molding; as an adhesive for sealing fiber cartons; for making milk-bottle caps; and for gumming tapes. Of the various copolymers or compositions of the two plastics investigated only those containing 85 per cent or more of vinyl chloride seem to have particular industrial interest.

In making the multifilament yarn of vinyon, the raw copolymer in the form of a white powder is dispersed in acetone to get a dope containing 23 per cent of the copolymer by weight. After filtering and deaerating the dope is spun the same as acetate rayon by the dry or air-spinning process. After conditioning on the take-up bobbins the yarn is twisted wet to avoid static with six turns per inch, whereupon it is given a stretch of over 100 per cent of its original length. As in the case of nylon, this stretching is a vital part in producing a good yarn so as to give it high tensile strength and true elasticity. The stretched yarn is then set by immersion in water at 150 F for several hours, after which it is ready to be wound to cones or skeins as the case may be.

The ordinary yarn is bright but may be dulled by incorporating finely ground pigments in the spinning dope just as is done in the case of viscose or acetate rayons. The tenacity or tensile strength may be controlled within a range of 1 to 4 grams per denier (19,300 to 77,200 psi) and the elongation correspondingly from 120 per cent to 18 per cent, the higher strength corresponding to the lower extensibility and vice versa. Being extremely water-repellent the tenacity and extensibility of the dry and wet yarn are the same. Although it is thermoplastic and softens at temperatures above 150 F, it does not support combustion.

During textile processing it is customary to run with rather high humidity because of the static which develops. The knitting properties are good since vinyon, due to its high strength and elasticity, can be knit under higher tension thus producing a tighter stitch than is possible with other fibers. Both the yarn and fabrics are in no way affected by water and are exceptionally resistant to acids and alkalies. In contact with ether or the lower aromatic hydrocarbons it tends to swell, but it is unaffected by alcohol, gasoline, and other similar hydrocarbons. Vinyon is not attacked by bacteria, molds, or fungi, and will not support their growth. It does not conduct electricity and, as water does not affect it, is an excellent

insulator. The staple fiber of vinyon blended with natural fibers like cotton or wool, or with rayon, can be made into fabrics which will retain a pressed shape, fold, or crease.

Uses suggested for the new textile fiber include filter fabrics, fishlines, nets, seines, electric insulation, shower curtains, bathing suits, waterproof clothing, acid- and alkali-resisting clothing, fireproof awnings and curtains, upholstery, fabrics, and hosiery.

Employment in Manufacturing

OCCUPATIONS

THE population of the United States increased about 6.34 per cent (between July 1, 1929, and July 1, 1937) while all manufacturing employment increased about 7.9 per cent, states Lyle M. Spencer in an article on "Employment Trends in Manufacturing," which appears in the April, 1940, issue of *Occupations*. Both of these figures seem to indicate that employment in manufacturing recovered remarkably well from the trough of the depression.

Possibly the fastest growing and certainly the most unusual industry in this group is the coin-machine vending business, which during the period increased its number of workers no less than tenfold. Originally confined to the manufacturing of "one-armed bandits," or slot machines, the industry has begun to diversify so that today cigarettes, perfume, little blue books, hamburgers, and phonograph records are sold through coin machines. Already employing more than 70,000 workers, some 20,000 of whom are engaged in manufacturing activities, these coin machines may be opening up a new method of merchandising.

Another sensational new industry is the plywood-making business, whose sales have nearly quadrupled in size during the last four years. Depending fundamentally on new kinds of glue introduced about 1930, the field now employs something like 12,000 people. The making of plastics and synthetic resins tripled or quadrupled the number of workers needed between 1929 and 1937 and now employs about 17,000 workers. After the repeal of prohibition, peculiarly enough, nonalcoholic beverage making declined hardly at all, but the makers of ice cream and confections were seriously hurt. The making of alcoholic beverages required the addition of nearly 62,000 new workers.

Table 1 indicates the other industries where employment increased at a significantly faster rate than the population between 1929 and 1937. Although space does not permit the listing here of employment increases in gross numbers, it is a curious thing to note that practically none of the increases in any one line is very large. It exemplifies a point that many are prone to overlook, but which students of technology have been emphasizing for some time, that no important change comes overnight. Rather, it comes in a long series of relatively short jumps.

There naturally were a number of industries which lost ground in terms of employment between 1929 and 1937. Some of the more important of these are cigar making, silk processing, tires and tubes, building materials, manufactured ice, confections and ice cream, wooden boxes, cotton textiles, furniture, rubber boots and shoes, women's hats, silverware, and jewelry. While the employment declines in some of these fields were serious, such as cigar making which lost about 28,000 people and the making of tires and tubes which lost 20,000, these losses were not in the aggregate large enough to prevent employment in the whole field of manufacturing from growing. However, despite the claims of some, the problem of unemployment cannot be solved simply by increasing the number of employment opportunities in the field of manufacturing because only about one worker out of five, for the country as a whole, is making his living through labor in the manufacturing industries.

TABLE 1 EMPLOYMENT INCREASE IN AMERICAN INDUSTRIES, 1929-1937, BASED ON DATA TAKEN FROM U. S. CENSUS OF MANUFACTURES AND OTHER SOURCES

	Per cent of Employment Increase (1929-37 unless otherwise specified)	
INDUSTRIES EMPLOYING MORE THAN 50,000 WAGE EARNERS		
Beverages	205	
Mechanical Refrigerators	94	(1931-37)
Stamped and Pressed Metal Enamel Ware	53	
Rayon and Allied Products	41	
Canned Goods	38	
Wire Work (N.E.C.) + Drawn Wire	29	
Motor Vehicle Bodies and Parts	29	
Chemicals (N.E.C.)	27	
Steel Works and Rolling Mills	22	
Converted Paper Products	20	
Bread and other Bakery Products	19	
Glass and Glass Products	17	
Ship and Boat Building	13	
Knit Goods	11	
INDUSTRIES EMPLOYING FROM 25,000 TO 50,000 WAGE EARNERS		
Radio Apparatus and Phonographs	33	(1931-37)
Machine Tool Accessories	23	
Rubber goods, other than Tires, Boots, and Shoes	20	
Butter, Cheese, Condensed and Evaporated Milk	11	

	Per cent of Employment Increase (1929-37 unless otherwise specified)	
INDUSTRIES EMPLOYING FROM 20,000 TO 25,000 WAGE EARNERS		
Aircraft and Parts	63	
Cash Registers, etc. (office machines)	40	
Lithographing	27	
Pocketbooks and small leather goods	27	
Typewriters and Parts	26	
Wood Turning and Shaping	23	
Aluminum Products	12	
INDUSTRIES EMPLOYING FROM 15,000 TO 20,000 WAGE EARNERS		
Synthetic Resins	195	(1931-37)
Photographic Supplies	42	
Corsets, etc.	20	
Cutlery	12	
Mattresses and Bed Springs	12	
INDUSTRIES EMPLOYING FROM 10,000 TO 15,000 WAGE EARNERS		
Asbestos Products	61	
Wallboard, Gypsum	41	(Est.)
Feed for Animals and Fowls	41	
Gloves	37	

LETTERS AND COMMENT

Brief Articles of Current Interest Discussion of Papers in Previous Issues

Braking High-Speed Trains as an Engineering Problem and the Problem of Solid Friction

To the Editor:

Mr. McCune[1] refers to the wide latitude of coefficients of friction for dry unlubricated surfaces which are tabulated in various handbooks. Recent investigations[2,3] of unlubricated friction show that the "coefficient of friction" is not a physical constant of the bulk properties of the two solids in contact, but is largely influenced by the nature of the adsorption and oxide layers with which their contacting surfaces are coated. Indeed, the laws governing unlubricated friction are still obscure. An attempt[4] to correlate dry friction of metals with one physical constant of the sliding components, their melting point, must be considered to have failed.[5] At present, empirical formulas, which some textbooks present for the use of the railway engineer and in which the coefficient of friction is assumed to be a constant of the material, do not seem to be of the least practical value.

Braking of high-speed trains is definitely a friction problem, occurring in engineering practice. It is a particularly complex friction problem, because it involves sliding friction and rolling friction simultaneously. These conditions are obscured by the introduction of a "coefficient of adhesion," "defined as the ratio of the braking friction (retarding force), acting upon the wheel, to the load carried by the wheel when slipping impends." Mr. McCune certainly does not express the physical problem accurately by saying that "the maximum retarding force at the rail is secured when the wheel rolls freely, because then the friction between wheel and rail is static or a maximum; whereas, when the wheel slips or slides, the friction between rail and wheel is kinetic and is correspondingly reduced."

The physicist defines "static friction" as the force required to start relative motion (sliding or rolling) between two solids in contact. "Kinetic friction" is defined as the force required to maintain constant speed of relative motion (either sliding or rolling). When the wheel starts to roll, the friction of rolling between wheel and rail is static. But, when the wheel rolls freely without being subjected to either an accelerating or retarding force, the friction is kinetic. It is still a matter of conjecture whether or not kinetic friction is of the same magnitude as static friction. It is often claimed that kinetic friction is smaller than static friction, while some investigators have been unable to find any dependence of friction upon speed of relative motion and others have claimed larger coefficients of kinetic than of static friction.

While the wheel rolls with respect to the rail, it slides with respect to the brake shoe or the disk brake. It is common experience that rolling friction is smaller than sliding friction. "Traces" due to both phenomena have been obtained.[2] Made visible by means of physical development with silver, they are quite similar in appearance when observed with the naked eye, Figs. 1 and 2. Each has the appearance of a thin scratch. Observation under the microscope, however, reveals their essentially different nature, Figs. 3 and 4. The trace of sliding is resolved into wide bands, consisting of a great number of parallel lines. The trace of rolling shows a milky-way pattern composed of numerous isolated specks. Such milky-way patterns were obtained with metal spheres which rolled down inclined glass plates. It was observed that the isolated specks were approximately circular for small tilting angles of the plates and became more and more elongated in the direction of rolling, when the tilting angle was increased. This suggested

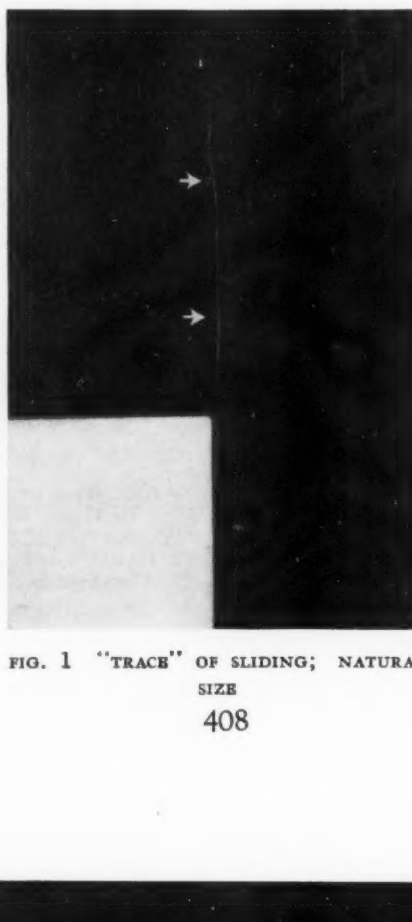


FIG. 1 "TRACE" OF SLIDING; NATURAL SIZE

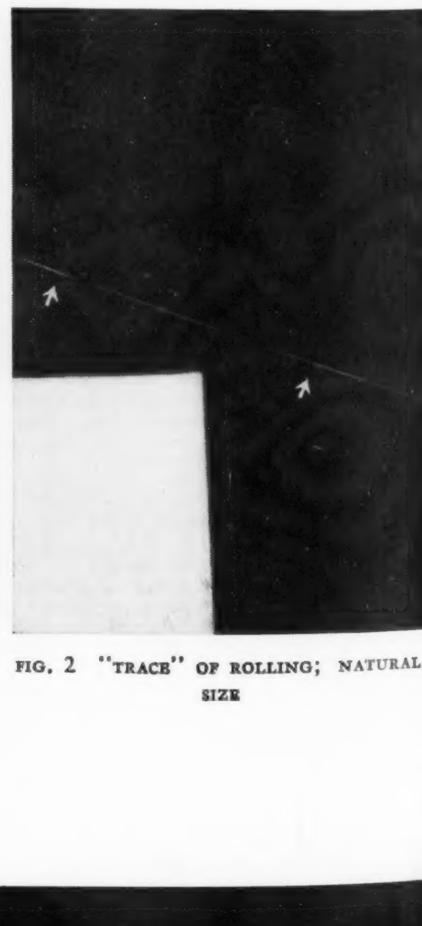


FIG. 2 "TRACE" OF ROLLING; NATURAL SIZE

[1] "Braking High-Speed Trains as an Engineering Problem," by J. C. McCune, Mechanical Engineering, vol. 61, 1939, pp. 583–588 and pp. 657–660.

[2] "Experiments on the Elementary Mechanism of Solid Friction," by R. Schnurmann. Awaiting publication.

[3] "The Friction of Clean Metals and the Influence of Absorbed Gases. The Temperature Coefficient of Friction," by F. P. Bowden and T. P. Hughes, Proceedings of the Royal Society of London, series A, vol. 172, 1939, pp. 263–279.

[4] "The Nature of Sliding and the Analysis of Friction," by F. P. Bowden and L. Leben, Proceedings of the Royal Society of London, series A, vol. 169, 1939, pp. 371–391.

[5] "The Sliding of Metals," by R. Schnurmann, *The Engineer*, vol. 168, 1939, p. 278.

that the elongation of the specks was a measure of the amount of slip involved in any process of rolling.

Similar observations were made under practical conditions. Immediately after a train has passed over the track, a bright continuous band about 1 cm wide may be observed on the surface of the rail. Microscopic observation shows that this apparently continuous band actually consists of elongated, isolated specks, characteristic of a trace of rolling, Fig. 5.

There are two immediate physical reasons why a high-speed train should be stopped by repeating the application and release of the brakes several times. It is desirable that the retarding force should act exclusively at the contact area of the brake shoes with the wheel and not at the contact of the wheel with the rail. Since the coefficient of sliding friction f_{slid} is larger than the coefficient of rolling friction f_{roll}, the wheel exerting a load W on the rail would cease to rotate under the action of the brake shoes exerting a load $2 \times \frac{W}{2}$ on the wheel, Fig. 6, before the train would come to rest. The braked wheel would lock and slide along the rail with the result of a slid-flat wheel, i.e., appreciable wear over a small part of the wheel rim and loss of the smooth-running quality of the wheel.

Mr. McCune clearly emphasizes the great variability of the coefficient of friction. Calculations for engineering purposes, based upon coefficients of friction are useless, unless the coefficient has been determined under conditions exactly similar to those occurring in the example to which its value is being applied.

The conditions of speed and load, as they occur in modern high-speed braking, must be considered as extreme from the point of view of sliding friction. It is interesting to note from Mr. McCune's paper[1] that the friction of brake shoes under these extreme conditions does not decrease, but increases. Laboratory experiments under controlled conditions have shown that "naked" metal surfaces in vacuo at room temperature have coefficients of static friction in the order of magnitude of unity, whereas oxidized surfaces show considerably larger coefficients of friction. Their coefficient of static friction may even assume an infinite value. Now, $f_{stat} = \infty$ means that no relative motion can take place along the area of contact, it can only occur by tearing one of the contacting components, i.e., a finite force is able to move relatively two sliding components, even if $f_{stat} = \infty$, because the shear strength of the materials has a finite value. Furthermore, what might appear to be a value of f_{kin} might be smaller than unity and might actually be the shear strength of an oxide layer. However, in this case, the plane of relative motion is not the interface between the two sliding components, e.g., brake shoe and wheel, but a plane parallel to it through the asperities of, e.g., the oxidized surface.

Under conditions in which the wheel rolls freely without application of the brakes, the heat evolution is moderate; the surface of the wheel rim is not appreciably oxidized. Abrasion plays a secondary part in the mechanism of solid friction, but its effect is more pronounced for oxidized surfaces than for surfaces free from oxides. When the brakes are applied, the temperatures of the brake shoes and of the wheel rise considerably and, therewith, their rate of oxidation and, consequently, their rate of wear. High-speed braking must always involve a considerable amount of wear. However, it is desirable to have circular symmetry of wear along the circumference of the wheel rim and to avoid the slid-flat

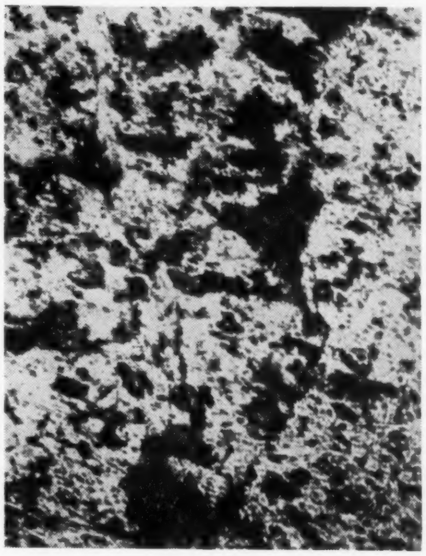


FIG. 5 PHOTOMICROGRAPH OF SECTION OF TRACE LEFT ON RAIL SURFACE AFTER PASSAGE OF TRAIN. ×50

(With the naked eye the trace appears as a continuous white band about 1 cm in width, but under the microscope it is resolved into isolated specks.)

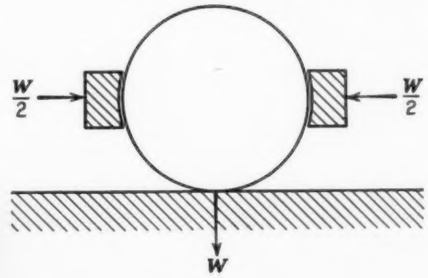


FIG. 6 WHEEL ON RAIL

FIG. 3 PHOTOMICROGRAPH OF SECTION OF TRACE OF SLIDING, FIG. 1. ×700

(White bands are multitude of parallel lines.)

FIG. 4 PHOTOMICROGRAPH OF SECTION OF TRACE OF ROLLING, FIG. 2. ×700

(Note isolated specks.)

wheel. It is for this reason that the brake pressure should be applied and released alternately, so that rolling of the wheel may be sustained throughout the entire process of dissipating the kinetic energy of the train.

"Flaming," although objectionable from the point of view of wear, does aid braking, since it contributes to an increase of the coefficient of friction. It is quite impossible to maintain constant or even consistent coefficients of friction under running conditions.

Mr. McCune draws attention to the amount of metal worn away and its lubricating effect. In principle, the existence of such an effect is feasible. If the material *C*, Fig. 7, which is worn away,

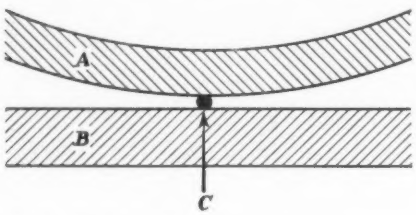


FIG. 7 PARTICLE *C* WORN AWAY BETWEEN WHEEL RIM *A* AND RAIL SURFACE *B*

is softer than the two components *A* and *B* in frictional contact, it might be crushed and the fragments might act as a kind of "molecular ball bearing." If *C* is harder than both *A* and *B*, it will grind a groove into the softer component and thus dissipate energy (effect of sanding). If finally, *C* is softer than *A* but harder than *B*, it will become imbedded in *B*, and the force of friction will then come into action between *A* and *C* instead of between *A* and *B*.

During the braking process, most of the material which is worn away flies off tangentially from the wheel (sparking). In the case of continuous braking, soft worn-away material, trapped between wheel rim and rail, may aid locking of the wheel between the brake shoes, before the kinetic energy of the train is completely dissipated. This might contribute to comparatively low rates of wear, but to unduly long stopping distances.

ROBERT SCHNURMANN.[6]

TO THE EDITOR:

I have read Mr. Schnurmann's comments with a great deal of interest. His statement that I did not express the problem of securing the maximum retarding force accurately appears to arise from the meaning attached to the words "static friction" and "kinetic friction." I used these terms as commonly understood in the brake art in this country. The fact that the retardation is diminished when the wheels slip or slide rests upon many experimental observations.

I cannot agree that a high-speed train should be stopped by repeating the application and release of the brakes several times. It is clear from road tests that such a method of braking would lengthen stop distances. Air consumption might be increased to a prohibitive degree by this kind of brake manipulation.

I quite agree that braking friction is an extreme case of sliding friction. The pressure and the speeds involved are so great that phenomena are encountered which are entirely absent in mechanisms other than brakes. Conclusions as to the friction to be expected can only be safely drawn from tests made under conditions approximating those to be expected in actual service. Predictions from small-scale experiments are likely to be found seriously in error.

JOSEPH C. MCCUNE.[7]

[6] Research Department, London, Midland & Scottish Railway Company, Derby, England.

[7] Director of Research, Westinghouse Air Brake Company, Pittsburgh, Pa. Mem. A.S.M.E.

Service Temperature Flow Characteristics of Thermoplastics

TO THE EDITOR:

The writer wishes to commend Mr. Bartoe for his fine presentation of a subject[8] of such vital interest to engineers. His comments on the significance of internal stresses to the intended application of the molded pieces are interesting, particularly because too little attention is usually accorded to this detail. It is known, for example, that in injection molding of test bars of polystyrene the properties of the test bar are dependent to a large measure upon the location of the injection gate. Test pieces with the injection gate at the end of the bar are more satisfactory in tensile strength and cold flow than test pieces with the injection gate or weld mark at the middle. Undoubtedly the internally stressed, unoriented macromolecules adjacent to the injection gates of the latter test bars contribute to the poorer physical properties. It has also been observed that stresses of this nature will affect the electrical properties of the material. For example, the dielectric strength of injection-molded cellulose-acetate materials are considerably lower at the weld mark than in the remainder of the article.

Data on the behavior of the materials at various temperatures are always of fundamental interest, particularly for the organic plastics. The writer is interested in knowing if the author possesses data for the materials at temperatures lower than shown in his curves, the minimum of which is 68 F. It is unreasonable to expect the tensile strength to increase indefinitely with lower temperatures. Perhaps there are some limiting maximum tensile strengths for the various thermoplastics. These values and the temperatures necessary to produce them would be of decided theoretical interest.

J. DELMONTE.[9]

[8] "Service Temperature Flow Characteristics of Thermoplastics," by W. F. Bartoe, MECHANICAL ENGINEERING, December, 1939, pp. 892–894.

TO THE EDITOR:

The paper by Mr. Bartoe provides the engineer with information not heretofore available regarding the stress-bearing characteristics of a particular plastic. More such data for other materials would be of value to industry.

Among the most striking of the effects noted is the astonishingly high influence of minor temperature changes. As can be seen on one of the diagrams, a change from 140 F to 68 F gives an increase in compressive stress at 10 per cent compression of from 4200 to 12,700 psi, or roughly, three to one. If this material should be placed outside where the temperature might go to 20 below zero, it would be expected that this change would be still more marked. It would be desirable if at some future time further experimentation were carried out under those conditions.

At a given temperature the effect on creep or plastic flow of increase in compressive stress is also high. The paper restricts itself to stresses in general which are greater than would be encountered in certain applications. Fig. 5 shows that probably the creep decreases more rapidly than the stress but it might be dangerous to extrapolate the curve shown. Thus one is left somewhat at a loss if he is to design this material for indefinite life under light stresses. For example, if an automobile window is to be designed using a plastic, the stress will be comparatively low, yet long life is desirable. At the present time it is realized that plastics are not yet developed to the point where they can be used in automobile windows because, at the moment, no plastic has been developed which has sufficient resistance to abrasion. Does Mr. Bartoe see any prospect of obtaining

[9] Research Engineer, Chicago Flexible Shaft Co., Chicago, Ill.

a plastic with a hardened surface for this purpose?

At the present time considerable interest is being shown in the use of glass blocks as a building material. Is there any likelihood of getting a plastic to stand such stresses as would exist in a building? In this case probably abrasion resistance would not be so important. Several questions arise regarding a material for such a purpose. Among them is the possible warping because of the change in temperature from the inside to the outside of the house. If an appreciable set were to take place, probably the desirability would be eliminated. If such a material could be developed, would the cost at the present moment be prohibitive compared to glass bricks?

In one of the diagrams Mr. Bartoe corrects compressive stress to take care of the increased diameter of the block during compression. It is not clear how this correction was made but if it is made so that the area at the center of the test piece is the area used for the revised stress, the writer would like to know what advantage taking this area has over the original area. Presumably this is more closely held near the contact with the metal plate, and the increase in stress near the plate would cause that section to yield more readily than at the center.

J. F. DOWNIE SMITH.[10]

TO THE EDITOR:

As Dr. Delmonte has pointed out, it is important to consider not only the external design of a molded or formed piece of plastic but also the internal stress pattern set up by the molding operation, whenever the best of dimensional stability, greatest strength, optical perfection, or optimum of many other characteristics are desired.

The accurate determination of the stress-strain characteristics of plastics at low temperature is somewhat difficult. Unfortunately the author's laboratory is not at present equipped for this type of work. Observations of the flexural strength of the material, for which data on tensile and comprehensive stress are given, indicate that a maximum strength condition is obtained at a temperature of approximately 30 F and below. These observations are made by bending chilled strips of the plastic around wood blocks of different diameters. For some other plastic materials this supposed maximum-strength temperature is considerably lower.

The abrasion resistance, scratch resistance, and penetration resistance of plastics are subjects of considerable discussion at the present time, as Dr. Downie Smith comments. No completely satisfactory methods have as yet been developed for measuring and correlating these properties either in plastics or other materials. This may be illustrated by pointing out that ordinary glass is more resistant to scratching by a steel point than is the acrylic resin known as Plexiglas. At the same time the Plexiglas is more resistant to deep abrasion from a sandblast than is ordinary glass. In general the organic plastic sheet materials have not been found satisfactory for use in automobile windows because they are so susceptible to scratching by small dirt particles.

It does not appear at the present time that an all organic plastic sheet with an appreciably hardened surface will be possible. Of course the hard surface can be obtained by an overlay of some other material but this unit then becomes essentially the laminated glass now so widely used in automobile windows. At the same time the author feels that the "glass-steel" of the wonder-story writer may become a reality sometime in the future when we know more about the nature of matter.

Building construction with transparent plastics is now possible on the same basis as it is being done with ordinary glass, namely, with self-supporting, nonloading bearing members. The principal factor to be observed in such construction with plastics is suitable allowances for expansion and contraction. Such constructions are not widely used as yet because of the prohibitive cost.

The correction applied to the observed curve of Fig. 4 was made on the basis of an assumed uniform change of cross section due to compression of height without change of volume. This is obviously an incorrect assumption, therefore the correction is of little value except to indicate the possible nature of the curve if it could be correctly determined. In other words the correction as applied is only a first approximation.

W. F. BARTOE.[11]

[10] Executive Engineer of Research, E. G. Budd Manufacturing Co., Philadelphia, Pa. Mem. A.S.M.E.

[11] Röhm & Haas Co., Inc., Philadelphia, Pa.

Unionization of Engineers[12]

TO THE EDITOR:

The interest shown in this subject by the underpaid and the mercenary is understandable, but the concern of the idealists is surprising.

If the service ideal is so loosely founded in an individual that it would be undermined by association with a union, then it will be wrecked anyway by association with the community at large.

Many union activities are definitely against the public good and must be combated. But to try to stop unionization for this purpose is futile. On the contrary, closer contact between unions and professional men may well lead to a better understanding of the common good and a gradual elimination of antisocial union activities.

Mr. Herron questions "whether a professional engineer, however badly underpaid he may be, should resort to union membership and activity to improve his condition." It would seem reasonable to answer that, if a decent living cannot be attained in any other way, then union activity is justified. The service ideal presents no objection in this case for it must be admitted that a decent living is a necessary prerequisite for rendering service.

However, aside from ideals, the practical aspects of union activities by and *for* engineers do not look very promising. A strike of engineers would not stop a manufacturing process or a construction project in very many cases. Drafting and many classes of testing can so easily be shifted to other concerns in other localities. To make the strike effective would require support and cooperation from unions of manufacturing and construction workers. To bargain for cooperation on basis of reciprocity is useless, since the other unions can get along very well without the cooperation of the engineers. Further exploration of these aspects will show that only in exceptional cases can an engineers' union be in a strong position.

Underpaid engineers, who may benefit temporarily from union activities, could be helped most effectively by reliable statistics of prevailing salaries and wages. It is well recognized that any business concern which consistently pays less than prevailing rates will end up with inferior personnel. Most concerns are therefore anxious to pay as much as anybody else in the same personnel market. But this natural wage policy is hampered by lack of reliable and comprehensive information.

Detailed statistics are needed for the low-pay engineering occupations classified according to kind of work and local-

[12] A fifth group of letters commenting on an article "Unionization of Engineers," by James H. Herron, MECHANICAL ENGINEERING, vol. 61, November, 1939, pp. 788–789 and 822.

ity. For comparison, these statistics should include engineering union wage scales and some of the skilled-trade union rates.

It would be advantageous for all the professional engineering societies to get together on this project, and it is to be hoped that this can be accomplished and work started within a short space of time.

GOSTA ANBRO.[13]

TO THE EDITOR:

I have noted with some concern articles printed in MECHANICAL ENGINEERING on the subject of unionization of engineers.

I think my concern is due to a feeling that the engineering profession which I, like many others, experience some kind of pride in belonging to, seems to be drifting into an aimlessness, or at least a competition of authorities.

There is the professional-society membership, there is the engineer's license to practice, and now there is this question of unionization.

Since most of us are in the profession to get our living, it is becoming a serious question in my mind as to whether what aid we can get through known connection with one of the sources in the foregoing paragraph is not likely to become neutralized by hindrance injected from the other two sources.

Does anybody think that any professional engineers seriously want unionization? Do the companies employing professional engineers have any kind of an idea that they want the engineers shoved into the collective-bargaining agencies now required under law?

I don't know much about it, but it seems to me that if the A.S.M.E. publishes anything on unionization, it should be along the line of opinions from employing companies concerning what they want the engineers to do, whether they must have them unionized.

To my mind, for individual engineers themselves to have published in MECHANICAL ENGINEERING their own views of what they would like is very likely to bring about some action which may put us all on the spot.

We hear sometimes that there are too many engineers, and we hear at other times that corporations cannot get enough good men with engineering training. As I see it, if engineers became unionized, it would not make them better engineers.

Association with the A.S.M.E. is supposed to imply that a man has some standing. Why isn't this enough for many men? And this membership, with the license, for certain individuals, especially those employed in civil service, where commissions have come to demand licenses and pay no attention whatever to national-society membership.

I have written this letter not in the hope that you will publish it, for if many other members feel the way I do, I don't believe you will be publishing much more on unionization. If you do, I don't believe many will take it seriously.

All that will happen is that members will not read, and that is not a serious thing for the member today.

If many members are like myself, they have their own reasons for paying dues into the Society, and very little the Society does affects these reasons. I have an instinct—who does not?—that I need standing and connections. It seems to me that is what engineers need continuously.

And if others feel the way I do, I am going to keep the connections, and perhaps the more the merrier. The only thing is, it is up to me myself to judge whether these connections conflict with each other, and when to use the one reference and when another.

I suppose that if getting a certain job means that I shall have to fill out an application form that I am connected with the Union of Engineers, I shall have to connect with the union, or else not get the job. I have filled out applications which require that I shall have a license. But I do not recall filling out an application which asks for details of my engineering-society activities, other than per haps to say I am a member.

I hope you will pardon this letter, as perhaps it interests myself more than it does you, or other members. I think you could gather from it I should be opposed to unionization if it came to the question of the A.S.M.E. putting out a letter ballot on it.

JAMES M. SHERILLA.[14]

TO THE EDITOR:

Engineers are not generally regarded as a professional group; they are not recognized as professional men by the public; and in many cases they are not so regarded by their own employers. The founder engineering societies should foster a campaign to improve this condition and let it be known that the engineering profession is not composed of a laboring class of people, that the men in this profession are not living "by the hour," or "by the week," and are not working "on piecework." In genéral, they have aims which reach far beyond the next pay check.

It is inconceivable that the philosophy (aims) of the engineering profession and that of a labor union should have anything in common; the engineer is frequently the "middleman" between the industrial management and the unionized shops, hence his mutual effectiveness would be greatly reduced if he were a member of a union. A real engineer, one who feels himself a part of the profession, will not be tempted by the lures of a present-day labor union. There is no more justification for close relations to exist between the engineering profession and a labor union than there is between the labor union and the legal or medical profession.

Engineering is a profession, and in order to obtain success in his profession, the engineer cannot afford to be hampered by limited hours, strikes, and wage controversies any more so than a lawyer or a doctor.

No doubt, the subprofessional group, composed of draftsmen, trainees, and men in strictly routine jobs, are or may become more susceptible to unionization. Many of these men work by the hour and must punch the time clock (because of the wage and hour law), hence they are considered in the same industrial group as machinists and steam fitters and are drawn away from the professional group. Regimenting this subprofessional group of engineers into a union would not be very difficult in some cases; this might be the beginning of a subsequent larger-scale unionization of engineers.

In order to establish a better relationship between the subprofessional group and the engineering profession, the founder engineering societies should sponsor the organization of these subprofessional groups and direct the activities of such clubs. This would not necessarily prevent these men from joining a union but it would have a tendency to make them feel a part of the engineering profession rather than of the laboring class.

The time has arrived for engineers to get together and "sell the public" on their profession, rather than be apologetic for their lack of so-called cultural attainments. There are many civic clubs—Rotary, Lions, Kiwanis—who are always looking for a good speaker. This is particularly true in the smaller cities where there is not a wealth of first-class talent. There are few civic clubs that do not have at least one engineer in their membership; it should be a simple matter to arrange, through the engineer membership, for the program committees to invite visiting engineers to speak to these groups of community leaders. The founder engineering societies should get

[13] Jersey City, N. J. Mem. A.S.M.E.

[14] Brooklyn, N. Y. Jun. A.S.M.E.

their local sections interested in this program of civic-club contacts.

HOWARD E. DEGLER.[15]

Potential and Dynamic Wealth

TO THE EDITOR:

The progress made in the last 50 years surpasses that of any similar period of time and has produced a standard of living in the United States that was undreamed of by its founders. This was made possible only because men were free, free to work with no serious restrictions placed upon their honest efforts to continue to make the ever-present, inexhaustible potential wealth dynamic. But, something has happened. The comforts and leisure that were a part of the high standard of living have been abused, or misused!

Some think that to make money without labor or constructive effort is the goal, believing that wealth is money instead of realizing that money is only the symbol of wealth. The value of this symbol of wealth is created and maintained only by mental effort and physical labor applied to the potential resources of the land in order to make them dynamic and useful to creating real wealth in motion, of which money is the symbol.

To fix prices on commodities, or on man's labor, or the amount of things he is permitted to produce is no remedy for economic ills. Prosperity cannot be accomplished in this way. Any system which prohibits men from putting forth their honest and best efforts irrespective of trade, or profession, to convert potential or stagnant wealth into dynamic wealth is wrong and dishonest. Dynamic wealth is the only kind of wealth which can be circulated by its symbol known as money. It is not so much the money in gold, or any other form, which we have in vaults, that is important; it is the rate of circulation which is the true measure of wealth and prosperity. Circulation of money, the symbol of wealth, is important, and any system which impedes it impairs prosperity.

More homes cannot be built by forcing the rate of pay per hour upward and simultaneously reducing the amount of work that a man can normally do. To arbitrarily compel a worker to lay a lesser number of bricks than he can normally lay a day, or regulate the number of window frames he can set into position, or limit the number of tires a mechanic can produce, or the amount of pigs a farmer can raise, or the amount of grain he can reap (and even being paid to raise less) tends to destroy dynamic wealth and leads to impoverishment. The responsibility of the individual might be better appreciated if we realized that before man there was the earth upon which he was later privileged to live. This represents a treasure chest of infinite possibilities which mankind is permitted to develop and utilize.

Let us not only think of that part of the Original Creation which we recognize, such as coal, foodstuffs, ores, etc., but, also, let us recognize that everything that science has discovered is but the revelation of that which was originally part of the Original Creation, whether we think in terms of electrons, or the various physical rays. They are the things which have been revealed by man through the application of intelligence and labor upon the treasure chest of potential wealth. And, whoever shirks this responsibility in his calling retards progress and fails to better the standard of living.

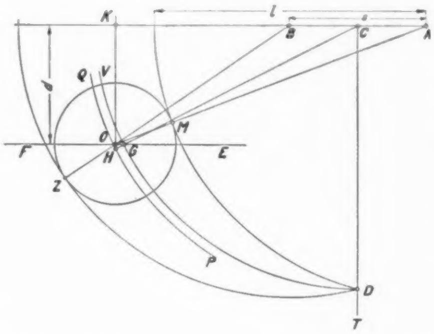
WILLIAM F. TRAUDT.[16]

[15] Austin, Texas. Mem. A.S.M.E.

[16] President and General Manager, Taber Pump Co., Buffalo, N. Y. Mem. A.S.M.E.

A Solution From China

SOME weeks ago Y. C. Chai, who is a student of the junior class of the department of mechanical engineering, The National Pei Yang University, Cheng-Ko, Shensi Province, China, submitted an original solution in a problem in mechanism involving the laying out of a Whitworth quick-return mechanism.



This solution was referred to A. E. R. de Jonge, adjunct-professor of kinematics, Polytechnic Institute of Brooklyn and member of the Committee on Machine Design, of the A.S.M.E. Machine Shop Practice Division. Mr. de Jonge has rephrased the solution offered by Mr. Chai and has commented on it in the following paragraphs.

* * * *

The solution presented by Mr. Chai concerns a rather ordinary problem in the theory of mechanisms, of which there exist so many. It is, however, interesting due to its straightforward nature and shows that the modern methods of geometrical kinematics have even penetrated into far-away China while, here, they are still not too well thought of and certainly not taught generally.

The problem which Mr. Chai has so nicely solved is as follows:

A Whitworth quick-return motion is to be laid out when the maximum stroke s of the ram, the length l of the connecting rod, and distance d of the crank center from the center line of the motion of the wrist pin on the ram are given. Unknown are the radius of the crank and the location of the crank center.

One way to solve this problem is by trial and error, i.e., by interpolation. This, however, is not very satisfactory. Instead, Mr. Chai proceeds in a direct manner as follows:

Let $AB = s$ be the maximum length of stroke on the wrist pin center line of the ram and EF a parallel to this center line at the distance d. The crank center must be located on EF. Draw the mid-perpendicular CT to AB. Using the length l of the connecting rod as radius, draw circles about A and B as centers, which meet in D on CT. Draw, further, two circles about C, one PQ with l as radius and the other DGV with CD as radius. The latter meets the parallel EF to AB in G. Draw CG which produced intersects circle PQ in H. From H drop a perpendicular HK on to AB. HK meets EF in the crank center O.

Proof: Join O with A and B and produce OB to Z, the intersection with the circle drawn about B as center with l as radius. If the radius of the crank be r, then

$$OA + OB = (l + r) + (l - r) = 2l$$

i.e., O is located so that the sum of its distances from A and B is constant $= 2l$. O lies, therefore, on an ellipse with A and B as foci and C as center, and on the parallel EF. The lengths of the major and minor semiaxes of the ellipse are l and CD, respectively. Circles drawn with these semiaxes about C as center are PQ and DGV. CG meets circle PQ in H. Hence, O, the intersection of HK and EF, is a point of the ellipse and, therefore, the crank center. OZ or OM is the crank radius.

A. E. R. DE JONGE.

A.S.M.E. BOILER CODE

Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revision of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place in the code.

The following proposed revisions have been approved for publication as proposed addenda to the code. They are published below with the corresponding paragraph numbers to identify their locations in the various sections of the code, and are submitted for criticism and approval from anyone interested therein. It is to be noted that a proposed revision of the code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets [ ]. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Committee for consideration.

PAR. P-332. Revise to read as follows:

P-332. *Inspectors. a* The inspection required by this Section of the Code shall be by an inspector continuously and solely employed as a member of a boiler inspection department of any state or municipality that has adopted the Code and which regularly employs one or more inspectors to make inspections of boilers within its jurisdiction, or by an inspector continuously and solely employed by an insurance company which is authorized by the state to insure boilers in the state in which the boiler is to be used. Such inspectors shall have been qualified by a written examination under the rules of any state which has adopted the Code and have then been commissioned by such state to inspect boilers during construction.

An inspector commissioned under the 1938 rules of the National Board of Boiler and Pressure Vessel Inspectors is qualified under the above requirements.

b Inspection. Each boiler, superheater, waterwall, steel economizer, and parts thereof shall be inspected during construction and after completion. At least two inspections shall be made of riveted construction (one before reaming rivet holes and one at the hydrostatic test) and, at the option of the inspector, at such other stages of the work as he may designate. For inspection of welded construction, see Pars. P-109, P-110, and P-112.

c Code Symbol. Each boiler, superheater, waterwall, and steel economizer shall be fabricated by and assembled under the supervision of a manufacturer of boilers, superheaters, waterwalls, or steel economizers who is in possession of a Code symbol stamp (See Fig. P-49).

d Data Reports. A boiler unit may be a combination of a boiler, superheater, waterwall, steel economizer, or other parts which require Code inspection. Shop inspectors shall clearly indicate on data reports the items which have been inspected.

(1) When such a unit is completely assembled and tested prior to shipment, the following reports in triplicate are required:

The manufacturer of the boiler shall furnish a manufacturer's data report, attaching thereto the necessary partial data reports, properly executed by the manufacturer and the inspector who shall sign the certificates of shop and assembly inspection, certifying that the unit conforms with the requirements of the A.S.M.E. Code. No field inspection or test is required unless specified by municipal or state law.

(2) When such a unit is supplied by the same or different manufacturers and is not completely assembled and tested prior to shipment, the following reports in triplicate are required:

The manufacturer of the boiler shall furnish a manufacturer's data report on the boiler which may include other parts manufactured by him in the same shop (a sample data report appears opposite page 130). If the boiler is of the water-tube type the form of manufacturers' data report for water-tube boilers shall be used (a sample report appears on page 218 of the 1938 addenda). Such report shall be signed by the manufacturer, limiting the data and coverage of the certification to products fabricated in his shop. The inspector shall sign the Certificate of Shop Inspection.

The manufacturer or manufacturers of the superheater, waterwall, steel economizer, or other parts shall furnish partial data reports properly executed by the respective manufacturers and inspectors of such parts (a sample report appears on page 129).

The above data reports shall be submitted to the field inspector. If the inspection of the field assembly and hydrostatic test show compliance with the Code, such reports shall be the authority of the field inspector to sign the certificate of field assembly inspection which will constitute certification of the manufacturers' compliance with all the requirements of this section of the Code.

e Tubes for All Types of Boilers. Tubes are not required to be inspected at the mill during manufacture by an inspector qualified under (*a*) of this paragraph, nor are they required to be stamped in accordance with (*f*) of this paragraph. The builder of the boiler, superheater, waterwall, or steel economizer shall be responsible for the tubes meeting Code requirements. The inspector making the final inspection shall determine if the tubes comply with these rules.

f Stamping. If the construction is in compliance with the Code, the builder shall stamp each boiler, superheater, waterwall, or steel economizer in the presence of the inspector, after the hydrostatic test, in the shop of the manufacturer. The stamping shall consist of the A.S.M.E. Code symbol (shown in Fig. P-49) which shall be put on each piece of equipment listed above in accordance with the locations given in Par. P-333. In addition to the symbol, the following items shall also be stamped with letters and figures at least $^5/_{16}$ in. high, having intervals of about $^1/_2$ in. between lines adjacent to the symbol as shown in Fig. P-50:

Items on boilers:

(1) Manufacturer's serial number.
(2) Name of manufacturer.
(3) Maximum allowable working pressure when built.
(4) Heating surface of boiler, in square feet.
(5) Year built.

Items on superheater, waterwalls, or steel economizers:

(1) Manufacturer's serial number.
(2) Name of manufacturer.
(3) Maximum allowable working pressure when built.

The above data shall be reproduced on a metallic plate, or plates, securely attached on the front of the boiler, its setting or casing, at a point readily visible from the operating floor. The boiler manufacturer shall furnish a plate incorporating the data, items (1) to (5), inclusive, and shall, if such part or parts were manufactured by him, incorporate the following items:

Heating surface of waterwall, in sq ft.
Heating surface of superheater in sq ft.
Heating surface of economizer in sq ft.

A space $1^1/_2$ in. wide by $^3/_4$ in. high shall be provided on this plate for inspector's reference markings. Each other manufacturer of a waterwall, superheater, or economizer, shall furnish a nonferrous plate, or plates, giving the manufacturer's name, serial number, and heating surface in square feet, which likewise shall be attached to the front of the boiler.

g Permission to use the symbol designated in the foregoing paragraph will be granted by The American Society of Mechanical Engineers to any manufacturer complying with the provisions of this code who will agree, upon forms issued by the Society, that any part to which the symbol is applied will be constructed in full accordance with the code requirements and that he will not misuse or allow others to use the stamp by which the symbol is applied.

h A steel stamp for applying the symbol

may be purchased by such manufacturer from the Society.

i No accessory or part of the boiler may be marked "A.S.M.E." or "A.S.M.E. Std." unless so specified in the Code.

PAR. P-333(3). Delete last sentence.

PAR. P-333(4). Add the words "and handhole opening."

PAR. H-66. Delete the second sentence.

PAR. H-81. Revise last sentence to the same wording as proposed Par. P-332*a*.

PAR. L-82. Substitute the following for the first four paragraphs:

L-82. *Inspectors. a* (Same as proposed Par. P-332*a*.)

b Inspection. Each boiler shall be inspected during construction and after completion. At least two inspections shall be made of riveted construction (one before reaming rivet holes and one at the hydrostatic test) and, at the option of the inspector, at such other stages of the work as he may designate.

c Code Symbol. Each boiler shall be fabricated by a manufacturer who is in possession of a Code symbol stamp (See Fig. L-5).

d Data Reports. The manufacturer of the boiler shall furnish a manufacturer's data report properly executed by the manufacturer and the inspector, who shall sign the certificates of shop and assembly inspection, certifying that the boiler conforms with the requirements of the A.S.M.E. Code. No field inspection or test is required unless specified by the municipal or state law (a sample report will appear following page 25).

e Tubes. Tubes are not required to be inspected at the mill during manufacture by an inspector qualified under (*a*) of this paragraph, nor are they required to be stamped in accordance with (*f*) of this paragraph. The builder of the boiler shall be responsible for the tubes meeting the Code requirements. The inspector shall determine if the tubes comply with these rules.

f Stamping. If the construction is in compliance with the Code, the builder shall stamp each boiler in the presence of the inspector, after the hydrostatic test, in the shop of the manufacturer. The stamping shall consist of the A.S.M.E. Code symbol (shown in Fig. L-5) which shall be located as specified in Par. L-83. In addition the following items shall also be stamped with letters and figures at least $^5/_{16}$ in. high having intervals of about $^1/_2$ in. between lines adjacent to the symbol as shown in Fig. L-6:

(1) Manufacturer's serial number.
(2) Name of manufacturer.
(3) Maximum allowable working pressure when built.
(4) Heating surface of boiler, in square feet.
(5) Year built.

g (Same as present sixth section.)
h (Same as present seventh section.)

i No accessory or part of the boiler may be marked "A.S.M.E." or "A.S.M.E. Std." unless so specified in the code.

PAR. L-84. Revise first sentence of this paragraph to read:

The data specified in Par. L-82*f* shall be reproduced on a metallic plate which shall be securely attached to the boiler head in the cab. A space $1^1/_2$ in. wide by $^3/_4$ in. high shall be provided on the plate for the inspector's reference markings.

PAR. M-20. Revise to read as follows:

a (Same as proposed Par. P-332*a*.)

b Same as proposed revision of Par. L-82*b* with the addition of the following sentence:

Inspection of welded constructions shall be made at the stages of the work designated by the inspector.

c Same as proposed revision of Par. L-82*c*, changing figure reference to "M-1" instead of "L-5."

d Same as proposed revision of Par. L-82*d*, with the addition of the following paragraph:

A data sheet shall be filled out for each boiler and signed by the manufacturer, this data sheet to include the most important items and to be numbered. In addition to this, the complete data sheet required for power boilers shall be filled out and preserved by the manufacturer for each lot of steel and each lot of boilers manufactured therefrom. The complete data sheet shall be marked to indicate to which boilers it applies and the manufacturer shall furnish copies of this complete data sheet when requested to do so by the owner of any one of the boilers. In requesting the complete data sheet the owner shall forward the number of the boiler which is stamped thereon in order that the manufacturer may readily identify the complete data sheet applying to the boiler.

This data sheet, together with the stamping on the boiler, shall be a guarantee by the manufacturer that he has complied with all the requirements of this section of the A.S.M.E. Boiler Code (a sample report will appear following page 14).

e (Same as proposed revision of Par. L-82*e*.)

f Stamping. If the construction is in compliance with the Code the builder shall stamp each boiler in the presence of the inspector, after the hydrostatic test, in the shop of the manufacturer. The stamping shall consist of the A.S.M.E. Code symbol (shown in Fig. M-1) which shall be located on some conspicuous and accessible portion of the boiler proper. In addition, the following items shall also be stamped with letters and figures at least $^3/_{16}$ in. in height, adjacent to the symbol as shown in Fig. M-2:

(1) Manufacturer's serial number.
(2) Name of manufacturer.
(3) Maximum allowable working pressure when built.
(4) Heating surface of boiler, in square feet.
(5) Year built.

For boilers having no pressure parts other than the steam generating coil or tubing, the required stampings may be placed on a separate, metallic plate not less than 3 by 4 in. in size which shall be irremovably attached to the front of the boiler casing.

No accessory or part of the boiler may be marked "A.S.M.E." or "A.S.M.E. Std.," unless so specified in the code.

g and *h*. (Same as Par. L-82*g* and *h*.)

PAR. U-65. Revise to read as follows:

U-65. *Inspectors. a* (Same as Par. P-332*a* replacing the word "boiler" with "unfired pressure vessels.")

b Inspection. Every pressure vessel shall be inspected during construction and after completion. At least two inspections shall be made of riveted construction (one before reaming rivet holes and one at the hydrostatic test), and, at the option of the inspector, at such other stages of the work as he may designate. For inspection of welded construction see Par. U-78.

c Code Symbol. Each pressure vessel or a part requiring Code inspection shall be fabricated by a manufacturer who is in possession of a Code symbol stamp (See Fig. U-8).

d Data Reports. An unfired pressure vessel may be a combination of one or more parts which require Code inspection. Shop inspectors shall clearly indicate on data reports the items which have been inspected.

(1) When a pressure vessel is completely assembled and tested prior to shipment, the following reports in triplicate are required:

The manufacturer of a pressure vessel shall furnish a manufacturer's data report, attaching thereto the necessary partial data reports, properly executed by the manufacturer and the inspector, both of whom shall sign the certificate of shop inspection, certifying that the pressure vessel conforms with the requirements of the A.S.M.E. Code. No field inspection or test is required unless specified by the municipal or state law.

(2) When the pressure vessel is composed of parts furnished by the same or different manufacturers and is not completely assembled and tested prior to shipment, the following reports in triplicate are required:

The manufacturer of the pressure vessel shall furnish a manufacturer's data report on the pressure vessel which may include other parts manufactured by him in the same shop (a sample data report appears following page 127). Such report shall be signed by the manufacturer, limiting the data and coverage of the certification to products fabricated in his shop. The inspector shall sign the certificate of shop inspection.

The manufacturer or manufacturers of other parts requiring shop inspection shall furnish partial data reports properly executed by the respective manufacturers and inspectors of such parts (a sample data report appears on page 127).

The above data reports shall be submitted to the field inspector. If the inspection of the field assembly and hydrostatic test show compliance with the code, such reports shall be the authority of the field inspector to sign the certificate of field assembly inspection which will constitute certification of the manufacturers' compliance with all the requirements of this section of the code.

e Tubes. Tubes are not required to be inspected at the mill during manufacture by an inspector qualified under (*a*) of this paragraph, nor are they required to be stamped in accordance with Par. U-66. The builder of the pressure vessel shall be responsible for the tubes meeting Code requirements. The inspector making the final inspection shall determine if the tubes comply with these rules.

PAR. U-66. Revise to read as follows:

U-66. *Stamping. a* If the construction is in compliance with the Code the builder shall stamp each pressure vessel in the presence of the inspector, after the hydrostatic test, in the shop of the manufacturer. The stamping shall consist of the A.S.M.E. Code symbol (shown in Fig. U-8) which shall be put on each vessel in the location given in (*b*). In addition to the symbol the following items shall also be stamped on the pressure vessel with letters and figures at least $^5/_{16}$ in. high having intervals of about $^1/_2$ in. between lines adjacent to the symbol as shown in Fig. U-9:

(1) Manufacturer's serial number.
(2) Name of manufacturer.
(3) Maximum allowable working pressure when built.
(4) Maximum allowable temperature corresponding with maximum allowable working pressure.
(5) Year built.

If the vessel is of fusion welded construction, or if it has welded pressure parts, it shall also be stamped with the number of the paragraph under which the welding was done.

If the circumferential or longitudinal joint or joints of a vessel are brazed, forge-welded, or resistance-welded, the vessel shall be stamped under the code symbol with the letters "BRZ," "FGD," or "RES," as the case may be. Where a vessel is built by combination of types of construction as mentioned above or different types of fusion welding, the stamping on the vessel shall indicate the different classes.

b The stampings shall be located on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole, or on a metallic plate brazed or otherwise irremovably attached to the shell plate. Such separate name plates shall be used on all vessels constructed of less than $^1/_4$ in. thickness instead of stamping the vessel itself. The stamping shall not be covered permanently with insulating or other material.

c When an unfired pressure vessel unit consists of more than one pressure chamber, operating at the same or different pressure, each such pressure chamber (vessel) shall be subject to the required inspections and hydrostatic tests.

The required hydrostatic tests shall be applied to each separate pressure chamber without pressure in the others. After passing the inspections and hydrostatic tests, each pressure chamber shall be stamped and a data sheet made out for each as required for a single vessel by Par. U-65.

d Permission to use the symbol designated in the foregoing paragraph will be granted by The American Society of Mechanical Engineers to any manufacturer complying with the provisions of this code who will agree upon forms issued by the Society that any vessel to which the symbol is applied will be constructed in full accordance with the code requirements and that he will not misuse or allow others to use the stamp by which the symbol is applied.

A steel stamp for applying the symbol may be purchased by such manufacturer from the Society.

Interpretations

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information on the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee.

This interpretation is later submitted to the Council of The American Society of Mechanical Engineers for approval after which it is issued to the inquirer and also published in MECHANICAL ENGINEERING.

Following is a record of the interpretations of this Committee formulated at the meeting of January 19, 1940, which were subsequently approved by the Council of The American Society of Mechanical Engineers.

CASE No. 709 (Reopened)

(*Annulled because of adoption of Table P-2 Revised*)

CASE No. 828 (Reopened)

(*Special Ruling*)

Inquiry: Is it permissible, under the Code for Unfired Pressure Vessels, to use nickel-clad materials for fusion-welded vessels?

Reply: It is the opinion of the Committee that unfired pressure vessels may be constructed of nickel-clad plates provided that all Code requirements covering design, welding, and tests for the class of service for which the vessels are intended are complied with, as well as the following additional requirements:

(*1*) The base plate material shall be in accordance with an approved steel plate specification, the required tests being made of specimens with the clad material removed. The bend test shall be made with the clad side in tension;

(2) Additional tension tests shall be made of the composite clad plate which shall meet the minimum requirements of base plate specifications. Two bend tests shall be made of the composite clad plate one having the clad material in tension and one having it in compression;

(3) The full thickness of the composite plate may be used in design calculations for Par. U-68 vessels provided the service temperature is below 250 F, and for other vessels provided that both the service temperature is below 250 F and the service pressure is below 100 lb. For all other vessels the thickness of the carbon steel base plate only shall be used in design calculations;

(*4*) The welding process qualification tests, the welding operator qualification tests, and the production test plates of Par. U-68 vessels shall include two free bend specimens, one of which shall be tested with the cladding in tension and the other in compression. Both shall meet the elongation requirement, measured over a gage length of not less than $^1/_2$ in. including the weld, for the class of construction required;

(*5*) The welds are completed before radiographing where this is required;

(*6*) The types of joints used be such that steel weld metal shall not fuse into the nickel layer and the depth of the nickel bead be kept to a minimum;

(*7*) No fillet weld be allowed in longitudinal or girth joints except for dished heads of Par. U-70 vessels convex to pressure (See Fig. U-14*c*).

It is important that the completed welds have a corrosion resistant property substantially equal to that of the nickel cladding. Until such a time as suitable rules to test corrosion-resistant properties of welds are formulated, the manufacturer should satisfy the purchaser that the weld is suitable for the intended vessel use. For operating temperatures in excess of 250 F consideration should be given in design of the vessel to the effect of thermal stresses arising from the difference in coefficients of expansion of the two materials.

CASE No. 860

(*Annulled because of adoption of Case No. 828 Reopened*)

CASE No. 884

(*Annulled because of adoption of Table P-2 Revised*)

CASE No. 892

(In the hands of the Committee)

CASE No. 893

(*Interpretation of Par. A-20*)

Inquiry: May fusible plugs be used which have different dimensions than those given in Par. A-20, but which have been approved for use in marine boilers by the U. S. Bureau of Marine Inspection and Navigation?

Reply: It is the opinion of the Committee that fusible plugs which are approved for use in marine boilers by the U. S. Bureau of Marine Inspection and

Navigation will meet the intent of the Code.

CASE NO. 894

(Interpretation of Par. P-299)

Inquiry: May the flanges and body thicknesses of valves and fittings be interpolated between the American Standards to provide for increased pressures instead of using the next higher pressure standard?

Reply: It is the opinion of the Committee that valves and fittings having the flange and body thicknesses increased to keep the same deflection limits and to give the same factor of safety as required under the American Standard will meet the intent of the Code.

CASE NO. 895

(Interpretation of Specification S-48)

Inquiry: Pending the adoption of a change in A.S.T.M. Specifications A209-38T which is identical with Specification S-48, will it be permissible in manufacturing superheater tubes by the forge welding process to use a minimum carbon content of 0.08 per cent for Grade T1 instead of 0.10 per cent as required, providing the material meets all other requirements of the specifications?

Reply: It is the opinion of the Committee that a lower carbon content may be used for Grade T1, of material complying with Specification S-48 under the conditions set forth in the inquiry.

Books Received in Library

HARDENABILITY OF ALLOY STEELS (Medium- and low-alloy steels—up to 5 per cent alloy). American Society for Metals, Cleveland, Ohio, 1939. Cloth, 6 × 9½ in., 318 pp., illus., diagrams, charts, tables, $3.50. This book contains nine papers presented at a symposium in connection with the twentieth (1938) annual convention of the American Society of Metals. They discuss the hardenability of steels containing up to five per cent of alloy. The physics of hardening, the hardenability of plain carbon and low-chromium steels, and the effect of additions of silicon and aluminum were among the topics discussed.

HIGH-SPEED DIESEL ENGINES. By P. M. Heldt. Third edition. P. M. Heldt, Nyack, N. Y., 1940. Cloth, 5½ × 8½ in., 475 pp., illus., diagrams, charts, tables, $4. The purpose of this book is to discuss the principles involved in the design and operation of this engine, in the light of the research work that has been done here and abroad. Automotive, aircraft, and railroad engines are considered, with special reference to the needs of designers and experimenters. One chapter is devoted to miscellaneous types of oil engines. This edition differs little from the preceding one, but contains an appendix covering the developments in research during the interval.

INDUSTRIAL ORGANIZATION AND MANAGEMENT. By R. C. Davis. Harper & Brothers, New York, N. Y., and London, England, 1940. Cloth, 6 × 10 in., 636 pp., illus., diagrams, charts, tables, $5. In 1928 Mr. Davis published "The Principles of Factory Organization and Management," designed as a text for students and junior executives. The present book is a complete revision of that work. In it an effort is made to draw a clear picture of the fundamental functions and principles of factory organization and management and their relations to one another, with a discussion of the specific problems that arise, illustrated by examples of the solutions adopted by various factories. There is a bibliography.

INDUSTRIAL SURVEYS AND REPORTS. By W. Rautenstrauch. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, London, England, 1940. Cloth, 6 × 9 in., 189 pp., diagrams, charts, tables, $2.50. This textbook outlines some of the problems engineers encounter in investigating and reporting industrial operations. The subject matter has been evolved from business and manufacturing experience, and actual situations are presented to the student, with field investigation required for a number of the problems. Appendix A contains a report, embodying the results of investigating a particular company, which exemplifies the material discussed in the text.

LEGAL ASPECTS OF ENGINEERING. By W. C. Sadler. John Wiley & Sons, Inc., New York, N. Y., 1940. Fabricoid, 6 × 9 in., 631 pp., $4. The purpose of this book is to provide engineers with a general understanding of the legal principles that govern engineering practice and of their application by the courts. The casebook method is used, over three hundred cases being presented, dealing with professional and industrial problems, aeronautics, property, and business.

M.K.S. UNITS AND DIMENSIONS AND A PROPOSED M.K.O.S. SYSTEM. By G. E. M. Jauncey and A. S. Langsdorf. The Macmillan Co., New York, N. Y., 1940. Cardboard, 6 × 9 in., 62 pp., diagrams, tables, $1. In 1935 the International Electrotechnical Commission adopted the meter, kilogram, and second as the basic units of length, mass, and time, this action becoming effective in January, 1940. This little book is intended to acquaint electrical engineers and physicists with the properties of this new system of basic units, to give reasons for the adoption of the ohm as the fourth basic unit, to describe a proposed meter-kilogram-second-ohm system of basic units, and to discuss the difference between magnetic-flux density and magnetic-field strength.

MATHEMATICAL METHODS IN ENGINEERING. By Th. von Kármán and M. A. Biot. McGraw-Hill Book Co., Inc., New York, N. Y., and London, England, 1940. Cloth, 6 × 9 in., 505 pp., diagrams, charts, tables, $4. In this introduction to the mathematical treatment of engineering problems the authors present methods in connection with their practical applications in the fields of civil, mechanical, aeronautical, and electrical engineering. Answers to the problems are collected at the end of the book. There are references with each chapter and a group of definitions of words and phrases.

MATHEMATICAL THEORY OF NON-UNIFORM GASES. By S. Chapman and T. G. Cowling. University Press, Cambridge, England; Macmillan Co., New York, N. Y., 1939. Cloth, 7 × 10 in., 404 pp., diagrams, charts, tables, $7.50. An account is given of the mathematical theory of gaseous viscosity, thermal conduction, and diffusion. The work is based on the methods originated by Enskog, and the chief formulas derived from the theory are discussed. The later chapters describe more recent work on dense gases, on the quantum theory of collisions, and on the theory of conduction and diffusion in ionized gases in the presence of electric and magnetic fields. There is a brief historical summary at the end, and a short bibliography is appended.

MOTOR UND KRAFTSTOFF. (Wissenschaftliche Herbsttagung 1938 des VDI in Augsburg.) V.D.I. Verlag, Berlin, 1939. Paper, 8 × 12 in., 106 pp., illus., diagrams, charts, tables, 10 rm. This publication contains 18 papers presented at a meeting of the Verein deutscher Ingenieure at Augsburg in 1938, with the discussions that ensued. The theme of the meeting was the reciprocal effects of the design of the engine details and the chemical and physical properties of the fuels upon the behavior of internal-combustion engines, especially Diesel engines.

PRINCIPLES OF INDUSTRIAL MANAGEMENT FOR ENGINEERS. By L. P. Alford. Ronald Press Co., New York, N. Y., 1940. Cloth, 6 × 9½ in., 531 pp., diagrams, charts, tables, $4.50. This book presents and interprets the teachings of management as related to the present period of economic and industrial transition. The subject matter covers the evolution of industry and of management in industry, organization and standards for the function of control, control of materials in manufacturing, time and motion-study fundamentals, classification and cost accounting, maintenance, rate setting, wages, and industrial relations.

RAILWAY ENGINEERING AND MAINTENANCE CYCLOPEDIA, Fourth edition, 1939. Edited by E. T. Howson and others. Simmons-Boardman Publishing Corporation, New York, N. Y., and Chicago, Ill., 1939. Fabrikoid, 8 × 12 in., 1008 pp., illus., diagrams, charts, tables, $5. Rewritten and revised to cover changes in the last ten years, the new edition of this authoritative manual supplies information on engineering, maintenance, and signaling, assembled under their principal headings, in the respective divisions of track, bridges, buildings, water service, and signaling. Methods, materials, and products are described, with supplementary manufacturers' pages giving detailed descriptions of specific products. These technical discussions are preceded by a section defining words, terms, and expressions which also acts as a general subject index. A directory of products, and indexes of trade names and manufacturers appearing in the volume follow the final section, which covers materials, processes, and equipment employed in more than one maintenance division.

THEORY OF PROBABILITY. By H. Jeffreys. Clarendon Press, Oxford, England; Oxford University Press, New York, N. Y., 1939. Cloth, 6½ × 9½ in., 380 pp., diagrams, charts, tables, $7. The chief object of this book is to provide a method of drawing inferences from observational data that will be self-consistent and also usable in practice. The principal types of problem treated in current statistical theory are discussed in detail, and a number of specific applications are given. Tables of K are given and the factorial function is discussed in appendixes.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. Semi-Annual Meeting in Milwaukee, Wis., June 17–20, 1940, Offers Much to Participants

Sessions of Applied Mechanics Division in Ann Arbor, Mich., June 20–21, and Oil and Gas Power Division in Asbury Park, N. J., June 19–22, Extend Scope of 1940 Semi-Annual Meeting of Society

NOT only is Milwaukee a great industrial city with hundreds of manufacturing plants exceptionally diversified in character, but it also offers to the visitor many attractions of a nontechnical nature, such as warm hospitality, delightful charm, scenic beauty, and all sorts of outdoor sports. That is why Milwaukee was selected to be host from June 17 to 20 for the 1940 Semi-Annual Meeting of The American Society of Mechanical Engineers, with headquarters at the Hotel Pfister. Fred H. Dorner, chairman, and Hans Dahlstrand and William D. Bliss, vice-chairmen, of the General Committee call the attention of A.S.M.E. members and their wives to the fact that their city is located only 89 miles by highway from Chicago and 930 miles from New York, and also that, with the general reduction of railroad fares in March, the round-trip coach fare from New York to Milwaukee is now only $30.35.

Technical Sessions

At the present time, 11 simultaneous technical sessions, covering the fields of hydraulics, power, management, fuels, machine-shop practice, and railroads, have been scheduled for the Milwaukee meeting, according to William M. White, program chairman. Besides the papers noted in the last issue of MECHANICAL ENGINEERING, others to be presented include:

"Turbulence and Energy Dissipation," by A. A. Kalinske, Iowa Institute of Hydraulic Research

"Steam-Turbine Blading," by R. C. Allen, Allis-Chalmers Manufacturing Co.

"Economic Draft-Tube Proportions," by A. R. Dawson, University of Toronto

"Chicago WPA Smoke Survey," by Osborn Monnett, consulting engineer

"Recent Developments in Burning Midwestern Coal in Water-Cooled Stokers," by H. C. Carroll

"Parallel Versus Individual Operation of Multicyclones," by L. C. Whiton, Jr., Prat-Daniel Corp.

"Use of Electric-Welded Construction for Columns and Bases in the Machine-Tool Industry," by F. O. Volz, Lakeside Bridge & Steel Co.

"Making Better Machine-Tool Castings," by F. J. Dost, Sterling Foundry Co.

"Control of Gases in the Wake of Smokestacks," by R. H. Sherlock and E. A. Stalker, University of Michigan

"History of Pulverized Coal," by Henry Kreisinger, Combustion Engineering Co., and John Blizard, Foster-Wheeler Corp.

"Notes on Trends in Valve Mechanisms as Exemplified in the Designs of New Steam Locomotives," by Charles F. Krauss, Baldwin Locomotive Works

"Train Acceleration and Braking," by R. Clark Jones, Harvard University

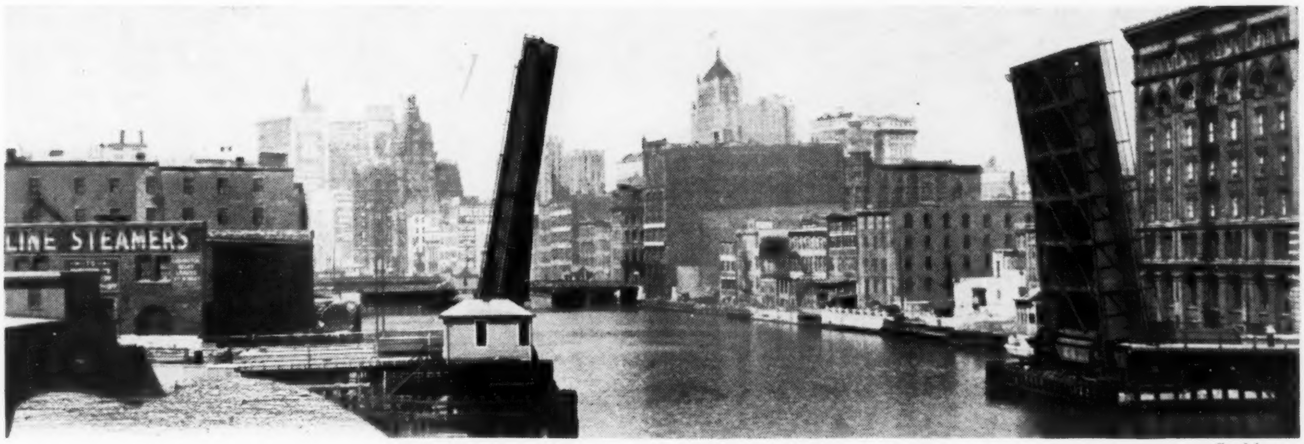
"Hard-Facing in Mechanical-Engineering Practice," by E. E. LeVan, Haynes-Stellite Co.

Milwaukee Journal Photo

LOOKING EAST OVER THE COURT OF HONOR, MILWAUKEE

Inspection Trips

Many of the manufacturing plants in and about Milwaukee will be open to A.S.M.E. members and their guests during the Meeting, states L. H. Stark, chairman of the Inspection Trips Committee. Several of the companies have already extended luncheon invitations for those visiting their plants. Final plans are not completed but the Committee says that the plants to be visited include makers of heavy machinery, such as the Allis-Chalmers Manufacturing Co., which builds steam and gas turbines, gas engines, oil engines, hydraulic turbines, pumps, cement and mining machinery, and many kinds of electrical equipment; the Falk Corporation, which manufactures oil



Cushing

THE MILWAUKEE SKY LINE

engines, flexible couplings, reduction gears, and heavy steel castings of all kinds; the Sivyer Steel Casting Company, which makes castings where the electric process for making steel is used; the Nordberg Manufacturing Company, which fabricates Diesel engines, uniflow steam engines, mining and other kinds of heavy machinery; and the Vilter Manufacturing Company, a leader in the field of refrigerating machinery.

The Kearney and Trecker Corporation and the Oilgear Company are makers of machine tools. Builders of cranes and general construction equipment include the Harnischfeger Corporation, Koehring Co., and the Chain Belt Co. Public-utility plants to be seen are those of The Wisconsin Electric Power Company, Metropolitan Sewerage Commission, and Milwaukee Water Works.

Entertainment

Besides providing facilities for sailing on Lake Michigan, swimming, golf, tennis, and other sports, the Entertainment Committee, under the chairmanship of Arthur Simon, is completing arrangements for a "stag" party on Tuesday evening, June 18, at the Pabst Breweries and a general luncheon on Tuesday noon. The biggest event of the four-day meeting will be the banquet on Wednesday evening, June 19.

Special Events for Women

The entertainment of the women will be under the direction of Mrs. R. C. Newhouse and her committee. Besides the many luncheons, trips, and shopping tours, the women's program includes their own exclusive party on Tuesday evening at the Schlitz Brewery.

To make the stay of A.S.M.E. members and wives in Milwaukee as pleasant as possible, a Reception Committee, E. C. Schum, chairman, will function during the Meeting. The Hotel Committee, Alex H. Luedicke, chairman, has already made arrangements for meeting headquarters at the Hotel Pfister but, in view of the hundreds of members who will register under the guidance of A. W. Lindstrom, chairman of the Registration and Information Committee, plans are being made to house the overflow at near-by hotels. Other members of the General Committee include W. C. Lindemann, chairman of the Finance Committee, and John D. Ball, chairman of the Publicity Committee.

Honorary Committee Members

Honorary chairman of the General Committee is Bruno V. E. Nordberg, son of the founder of the Nordberg Manufacturing Company and of one of the first members of the A.S.M.E., which is celebrating its Sixtieth Anniversary this year. The late Mr. Nordberg was also instrumental in organizing in 1904 the Milwaukee Section which was the first of the present 71 Local Sections of the Society.

The Midwest is well represented on the Honorary Committee for the Milwaukee Meeting, which includes the following members: R. T. Mees, Peoria, Ill.; Ralph E. Turner, Chicago, Ill.; Norman Bourke, Fort Wayne, Ind.; Earl D. Hay, Lawrence, Kan.; W. L. Ducker, Jr., Tulsa, Okla.; C. A. Koepke, Minneapolis, Minn.; Niles H. Barnard, Lincoln, Neb.; G. L. Larson, Madison, Wis.; C. C. Wilcox, Notre Dame, Ind.; Donald E. Dickey, St. Louis, Mo.; and R. A. Cross, Davenport, Ia.

Ann Arbor and Asbury Park Sessions

For the convenience of A.S.M.E. members and guests, some of the technical sessions of the 1940 Semi-Annual Meeting will be held in other cities besides Milwaukee. The Applied Mechanics Division will hold its sessions at the University of Michigan, Ann Arbor, Mich., June 20–21 (see page 421 for complete program), and the Oil and Gas Power Division is sponsoring several sessions and a technical exhibit in Asbury Park, N. J., June 19–22 (see page 420 for scheduled events).

Official Notice

A.S.M.E. Business Meeting

THE semi-annual business meeting of the members of The American Society of Mechanical Engineers will be held Monday evening, June 17, at 8 p.m. at the Hotel Pfister in Milwaukee, Wis., as a part of the Semi-Annual Meeting of the Society.

(*Signed*) C. E. DAVIES
Secretary

A.S.M.E. Members Invited to Industrial Medicine Meeting

AN invitation has been extended to A.S.M.E. members by the American Association of Industrial Physicians and Surgeons to attend the twenty-fifth annual meeting of the Association at the Hotel Pennsylvania, New York City, June 4–7. Papers at technical sessions will be devoted to problems of industrial health in all of their various medical, technical, and hygienic phases, with particular stress on prevention and control of occupational hazards.

A.S.M.E. Member Honored by Haitian Government

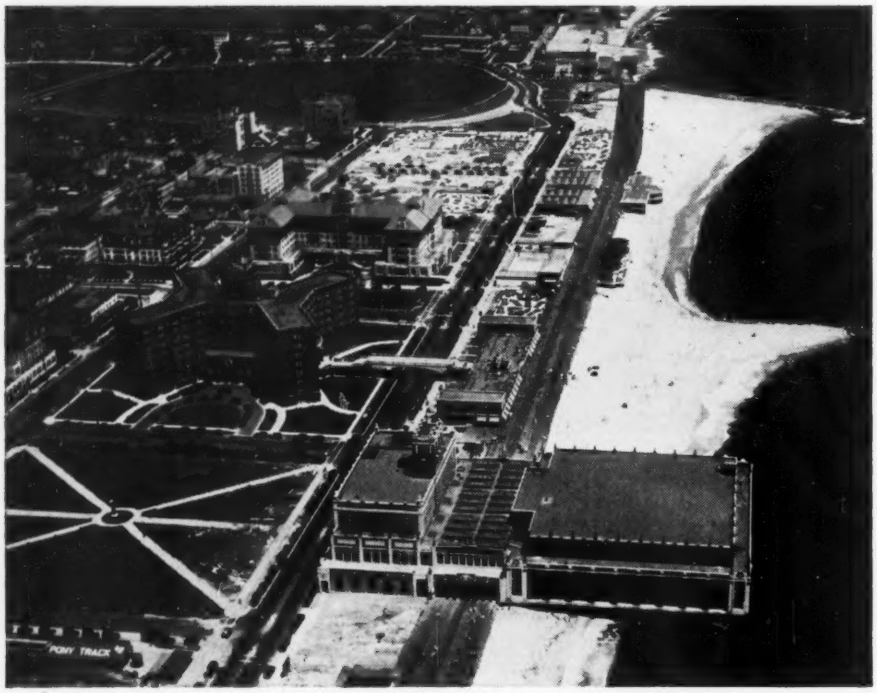
GANO DUNN, life member A.S.M.E., and president of J. G. White Engineering Corporation, was given recently by the Haitian government the decoration of the Order of Honneur et Mérite for outstanding service in the economic upbuilding of the Republic by his company.

List of Articles on Industrial Education, Training Available

A LIST of articles sponsored by the A.S.M.E. Committee on Education and Training for the Industries, from 1921 to 1939, is available to members upon written request to Ernest Hartford, A.S.M.E., 29 West 39th Street, New York, N. Y. The list includes the titles of 82 articles, many of which have been published in MECHANICAL ENGINEERING.

Prouty Colorado Examiner

GOVERNOR Ralph L. Carr has just appointed Frank H. Prouty, member of A.S.M.E. Council, to the Colorado State Board of Examiners of Engineers and Surveyors. He succeeds the late John A. Hunter.



HOTEL BERKELEY-CARTERET AT ASBURY PARK, N. J.

A.S.M.E. Oil and Gas Power Division to Meet at Asbury Park, N. J., June 19–22

Preliminary Program of Technical Sessions

THE Oil and Gas Power Division of The American Society of Mechanical Engineers is to hold its 1940 national meeting from June 19 to 22 at Asbury Park, N. J., with headquarters at the Hotel Berkeley-Carteret, where the second floor with its meeting rooms, exhibit hall, dining room, registration facilities, and lounges will be given over to those attending the conference.

Arrangements have been made for 27 exhibits, ten of which are already reserved. A preliminary program of the technical sessions will run something on this order:

Wednesday Afternoon, June 19

Fuels Session

Diesel Fuels for Large Unit Power Generation From the Operator's Viewpoint, by J. Bryan Sims, superintendent, Board of Public Works, Grand Haven, Mich.

The Houdry Refining Process and the Economic Future of the Diesel Engine, by J. B. Rather, Socony-Vacuum Oil Co., Inc., New York, N. Y.

Thursday Morning, June 20

Session on Shaft Coupling

Fluid Couplings, by N. L. Alison, hydraulic coupling division, American Blower Corp., Detroit, Mich.

Electric Ship Couplings, by A. D. Andriola, Electric Boat Co., Groton, Conn.

Thursday Afternoon, June 20

Session on Marine Diesel Engines

Nordberg's Contribution to the U. S. Maritime Commission Program, by R. W. Bayerlein, Nordberg Mfg. Co., Milwaukee, Wis.

Marine Applications of the Diesel Engine, by L. R. Ford, Editor, *Motorship*

Friday Morning, June 21

Mechanical Design Session

Stress and Deflection in Reciprocating Parts, by R. L. Boyer and T. O. Kuivinen, The Cooper-Bessemer Corp., Mt. Vernon, Ohio

Engine Balance and Importance as to Design, by Paul Shirley, General Machinery Corp., Hamilton, Ohio

Frame Stiffness and Engine Vibration, by J. Russel Pyles, Clark Bros., Co., Inc., Olean, N. Y.

Friday, June 21

Evening Session

The Combustion-Gas Turbine, by J. T. Rettaliata, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

Saturday Morning, June 22

Research Session

The Significance of Diesel Exhaust Gas Analysis, by John C. Holtz, U. S. Bureau of Mines, Pittsburgh, Pa.

The Effect of Variations in Atmospheric Conditions on Diesel-Engine Performance, by J. S. Doolittle, professor of mechanical engineering, The Pennsylvania State College, State College, Pa.

A number of plants operating Diesel engines in the vicinity of Asbury Park have granted permission for inspection by members attending the conference.

Entertainment at the conference will be featured by impromptu radio broadcasting during either luncheon or dinner by those members who care to give it a whirl. A local station features such a program from the Berkeley-Carteret daily.

A complete program will be ready for the June issue of MECHANICAL ENGINEERING.

Eastern Photoelasticity Conference, May 24–25

THE eleventh annual Eastern Photoelasticity Conference will be held at the Carnegie Institute of Technology, May 24-25. An interesting program is being arranged, according to word from M. M. Frocht, member A.S.M.E. and chairman of the committee on arrangements.

A.S.M.E. Calendar

of Coming Meetings

May 1–3, 1940
Spring Meeting
Hotel Bancroft
Worcester, Mass.

June 17–20, 1940
Semi-Annual Meeting
Hotel Pfister
Milwaukee, Wis.

June 19–22, 1940
Oil and Gas Power Division
Hotel Berkeley-Carteret
Asbury Park, N. J.

June 20–21, 1940
Applied Mechanics Division
University of Michigan
Ann Arbor, Mich.

September 3–6, 1940
Fall Meeting
Hotel Davenport
Spokane, Wash.

November 7–9, 1940
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions
Hotel Tutwiler
Birmingham, Ala.

December 2–5, 1940
Annual Meeting
Hotel Astor
New York, N. Y.

(For coming meetings of other organizations see page 18 of the advertising section of this issue)

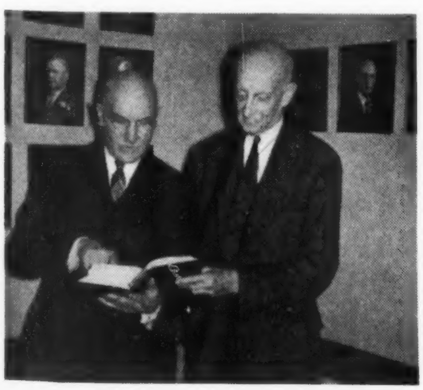
A.S.M.E. Management Division Broadens Its Scope and Activities in All Fields

New General Committee Includes Outstanding Leaders of American Industry, Finance, and Education

MANAGEMENT, the field in which The American Society of Mechanical Engineers is one of the recognized leaders of the world, has expanded to such an extent in the last few years that the Management Division of the Society at the April meeting of its executive committee decided to broaden the scope of its work. As part of this movement, prominent industrialists, financial administrators, and educators have accepted the invitation of the Division to serve on a General Management Committee, which will assist in making plans and in getting papers for the National Meetings of the Society.

Serving on the Committee

Serving on this committee are: Prof. L. P. Alford, N.Y.U.; L. A. Appley, Socony-Vacuum Oil Co.; Prof. R. M. Barnes, University of Iowa; W. L. Batt, SKF Industries; Prof. C. W. Beese, Purdue University; F. B. Ball, Edgewater Steel Co.; Wallace Clark, consulting engineer; H. V. Coes, Ford, Bacon & Davis, Inc.; K. H. Condit, dean-elect, Princeton University; Howard Coonley, National Association of Manufacturers; Norman E. Elsas, Fulton Bag & Cotton Mills; Ralph E. Flanders, Jones & Lamson Machine Co.; Walter D. Fuller, The Curtis Publishing Co.; W. H. Gesell, Lehn & Fink Products Corp.; Dr. Lillian M. Gilbreth, consulting engineer; R. E. Gillmor, Sperry Gyroscope Co.; Charles H. Hatch, National Can Corp.; Prof. E. H. Hempel, Columbia University; Prof. Paul E. Holden, Stanford University; W. F. Hosford, Western Electric Co.; Dean D. S. Kimball, Cornell University; T. S. McEwan, Stevenson, Jordan & Harrison; Prof. A. I. Peterson, N.Y.U.; Prof. D. B. Porter, N.Y.U.; Prof. F. E. Raymond, M.I.T.; Joseph W. Roe; Prof. Erwin H. Schell, M.I.T.; Prof. Elliott D. Smith, Yale University; L. W. Wallace, Crane Co.; and Prof. John Younger, The Ohio State University.



E. R. FISH AND D. S. JACOBUS

(Just before the meeting on April 4 of the A.S.M.E. Boiler Code Committee, Dr. Jacobus chairman, and Mr. Fish, vice-chairman, are shown with a copy of the 800-page code finding the answer to a question.)

Division Sponsoring Sessions at National Meeting

At each of the National Meetings of the Society, Worcester, May 1–3; Milwaukee, June 17–20; Spokane, Sept. 3–6; and New York, Dec. 2–5; the Management Division is sponsoring one or more sessions. Renewed emphasis is being placed this year on applying mathematical statistics to management's problems. Furthermore, in answer to the request of many A.S.M.E. members who are active in sales and product engineering, industrial-marketing sessions will be featured at the December meeting.

Plans are under way to give an opportunity in the near future for prominent industrialists to sit down at an informal, yet intensive, discussion of the handicaps to better and efficient administration of business caused by a lack of recognizing the proper principles of internal organization. Also being planned now is the National Management Conference in the spring of 1941 under the auspices of the Division in order to gather the latest thought in this country on the pressing problems of industrial management.

Cushing

THE PLANKINTON ARCADE BUILDING IN MILWAUKEE

(A.S.M.E. Semi-Annual Meeting, Milwaukee, Wis., June 17–20. See pages 418–419.)

The executive committee of the Management Division is made up of the following members: W. H. Kushnick, chairman, Harold B. Bergen, vice-chairman, G. M. Varga, secretary, L. C. Morrow, John R. Bangs, and James M. Talbot. These men help to shape the policies of a Division in which more than 4000 members of the Society are registered.

Applied Mechanics Division of A.S.M.E. to Hold National Meeting in June at Ann Arbor, Mich.

THE seventh national meeting of the Applied Mechanics Division of the A.S.M.E. will be held on the campus of the University of Michigan, Ann Arbor, Mich., on June 20 and 21. Plans for the technical program were completed at a meeting of the Executive Committee at A.S.M.E. headquarters on March 25. Papers will be presented in the fields of elasticity, dynamics, fluid mechanics, and thermodynamics, as follows:

Elasticity

S. TIMOSHENKO, *Chairman*

Influence Surfaces for Stresses in Slabs, by F. M. Baron
The Impact of a Mass Striking a Beam, by E. H. Lee
Effects of a Change of Poisson's Ratio Analyzed by Twinned Gradients, by H. M. Westergaard

Dynamics

J. P. DEN HARTOG, *Chairman*

Forty-Eight Ordinate Harmonic Analysis and the Harmonic Spectrum of Two-Cycle Diesel Torque, by Nancy Klock
Critical Speeds of the First and Second Order of Shafts Supported on Both Ends, by P. Kohn, M. Kampl, and J. Böhm
Impulse Blade Vibration, by R. P. Kroon
On the Computation of Axial Vibration Frequencies in Steam-Turbine Disks Especially in Those With Long Blades, by I. Malkin

Elasticity

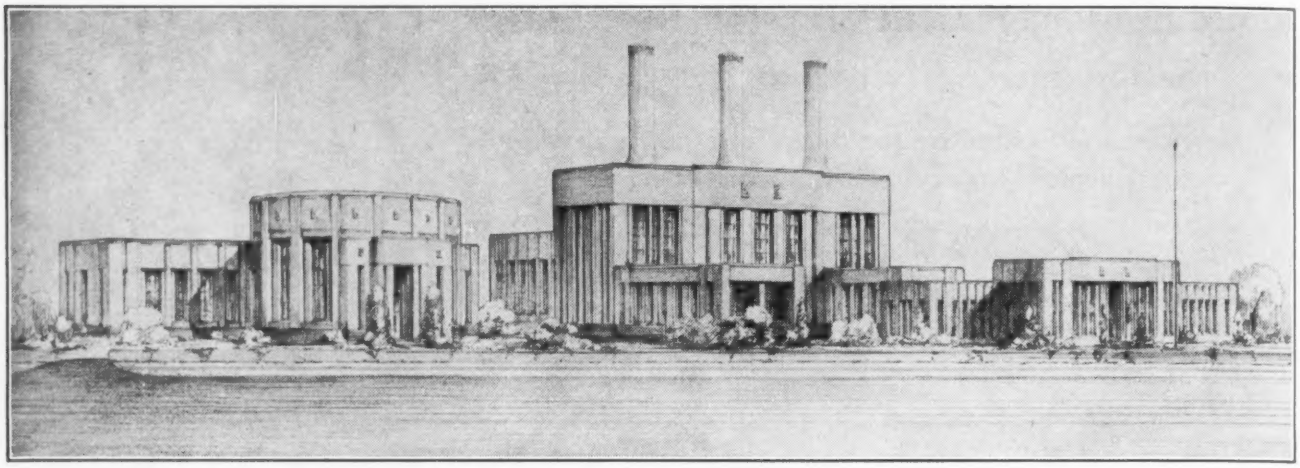
B. M. WOODS, *Chairman*

The Influence of Hyperbolic Notches on the Transverse Flexure of Elastic Plates, by George H. Lee
Convergence of Hardy Cross's Balancing Process, by Rufus Oldenburger
The Orthogonally Stiffened Plate Under Uniform Lateral Load, by H. A. Schade
Some Observations on the Theory of Contact Pressures, by S. Way

Fluid Mechanics and Thermodynamics

J. A. GOFF, *Chairman*

Flow Through Granular Media, by L. P. Hatch
Chart of Air-Vapor Mixture Properties at Different Pressures, by R. C. Binder



TWO-HUNDRED DETROIT SECTION MEMBERS VISITED THE NEW DETROIT SEWAGE-TREATMENT PLANT ON APRIL 2

(Following the inspection, a technical session was held in the Detroit-Leland Hotel at which the speakers were G. R. Thompson, M. E. Wagnitz, A. B. Morrill, and W. C. Rudd. Topics which were covered included a description of the plant, its sewers and regulators, layout, and mechanical operation.)

125 Attend Reading Session of Anthracite-Lehigh Valley

FOLLOWING a dinner at which W. H. Winterrowd, member of A.S.M.E. Council, said a few words, 125 members and guests of the Anthracite-Lehigh Valley Section took part in the March 22 meeting at Reading. T. V. Buckwalter, member A.S.M.E., told of the preliminary work and experiments of the Timken Roller Bearing Co. in equipping steam locomotives with roller bearings. This forced the engineers into considerable research on the design and operating characteristics of steam locomotives, which led to the steam-locomotive slipping tests, the subject of the meeting. O. J. Horger, member A.S.M.E., showed ultrafast motion-picture film giving close-ups of the driving wheels on slip tests running at speeds ranging from 60 to 107 mph. The discussion was led by R. Eksergian, fellow A.S.M.E.

Baltimore Section Is Host to A.S.M.E. Student Branches

Student members from Johns Hopkins and University of Maryland Branches were guests of the Baltimore Section at a dinner and meeting on March 12 in the Engineers Club. Preceding the talk of the evening, Charles Flagle, chairman of Johns Hopkins Branch, and L. K. Henninghausen, vice-chairman of Maryland Branch, told of the activities of their respective branches. The guest speaker of the evening, Gustave Fast, member A.S.M.E., gave an illustrated talk on the history and development of plain, ball, and roller bearings. There were 175 members and students present at this meeting.

Bridgeport Meeting on Surface Finish of Metals Attracts 200

E. J. Abbott, who has spoken this year before many A.S.M.E. Local Sections, was the speaker at the March 13 meeting of the Bridgeport Section. More than 200 members and guests turned out to learn about "Surface Finish of Metals."

Central Indiana Has Paper on Smoke Elimination

In a paper presented before 45 members and 15 guests of the Central Indiana Section, meeting in Terre Haute on March 15, Robert H. Kuss stated that public education in smokeless firing of local fuels under clear, enforceable ordinance, intelligently administered, would do most toward elimination of the smoke nuisance.

Modern Turbine Described at Central Illinois Meeting

Meeting in East Peoria on March 14, the Central Illinois Section had L. Hausmann, member A.S.M.E., and turbine engineer, Westinghouse Electric & Manufacturing Co., as the guest speaker. The subject of his paper was "The Modern Steam Turbine."

Central Pennsylvania Hears Paper on Aeronautics

O. E. Szekely, aeronautical engineer, gave a paper before the Central Pennsylvania Section of the Society on March 14, on the manufacture of aircraft.

Feedwater Regulation Is Subject at Charlotte

Charlotte Section met on March 20 and heard a talk by E. W. Nick, Northern Equipment Co. He gave a review of the problems he had encountered in his research into feedwater regulation. The talk was illustrated with slides showing parts of equipment which were designed as a result of the research study made in this field.

America Builds Ships, Cincinnati Section Told

The scene of the March 28 meeting of the Cincinnati Section was the Cincinnati Club. The speaker of the evening, Robert W. Horton, U. S. Maritime Commission, explained how the Commission functions. Design of merchant ships, operating and construction subsidies, and other features of the American program of expanding its merchant marine were discussed.

Cleveland Section Holds "Back-to-College Night"

Members of the Cleveland Section were guests of the Case Student Branch at the annual "Back-to-College Night" held at the school on March 21. The program consisted of lecture demonstrations on heating and ventilating, cutting fluids for machine tools, automotive testing, worm-gear lubrication, photoelasticity, and slotted airplane wings.

Personalities Discussed at Columbus Meeting

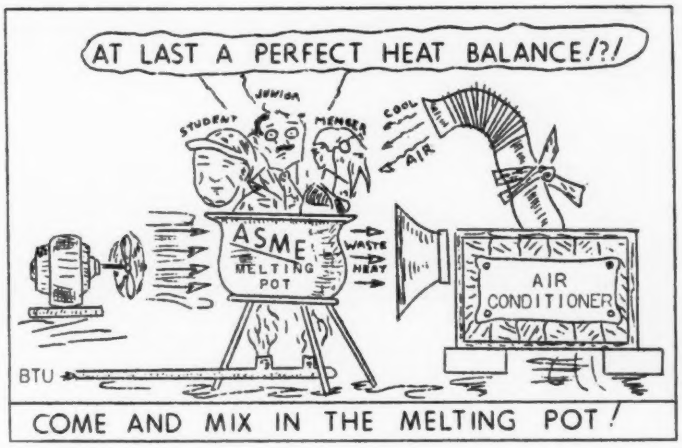
The annual dinner meeting and ladies' night of the Columbus Section on March 25 featured a paper on "Personalities" given by Dr. George T. Harding, psychiatrist. There were 23 members of the Section and 20 women guests present.

Dayton Section Conducts Inspection Trips March 28

Under the capable direction of C. L. Bauer, members of the Dayton Section made inspection trips on March 28 through the National Supply Co. and the Steel Products Co. plants of Springfield, which were terminated at the Springfield Country Club where dinner was served.

Florida Section Has Session at State Meeting

As part of the twenty-fourth annual meeting of the Florida Engineering Society, which was held at Hollywood Beach, Fla., April 11–13, the Florida Section of the A.S.M.E. sponsored a mechanical-engineering session, April 12, at which N. C. Ebaugh presided. Papers presented included a report of the Committee on Mechanical Engineering by its chairman, W. A. Lawrence; "Quick Freezing and Its Developments," by W. R. Woolrich, member of A.S.M.E. Council; "Research in the Topping-Turbine Field," by F. K. Fischer; and "Solar Water Heating in Florida," by J. T. Legget, University of Florida.



North Texas Section advertised a recent meeting with this cartoon

Talk on Locks Presented to 200 in Fort Wayne

Under the sponsorship of the Fort Wayne Section, more than 200 members and guests heard an interesting talk on locks given at the March 21 meeting by Maxwell C. Maxwell, Yale & Towne Manufacturing Co. Of particular interest to all was Mr. Maxwell's exhibit of ancient Egyptian and Roman locks.

Inland Empire Meets With Student Members in Moscow

Moscow, a town in Idaho, was the place selected by the Inland Empire Section for its March 2 meeting, which was held jointly with the A.S.M.E. Student Branches at Washington State College and the University of Idaho. Present were 12 members and 34 students.

Los Angeles Organizes Subsection in San Diego

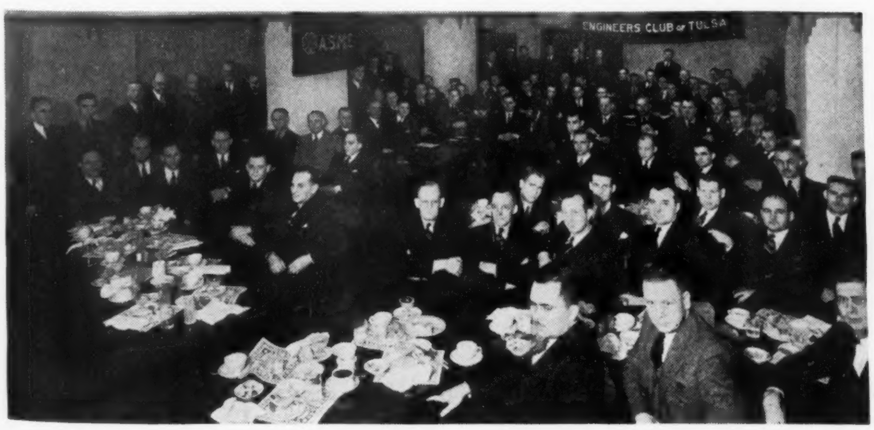
The growing number of A.S.M.E. members in the San Diego industrial area has caused the Los Angeles Section to organize a Subsection there for the purpose of affording local members an opportunity to hold meetings in the immediate vicinity for the purpose of discussing engineering topics of the day, development problems, and maintenance troubles. Present at the first meeting on March 22 were eight members from Los Angeles and 12 from San Diego. Information about future meetings in San Diego may be obtained from E. Kent Springer, Box 397, Vernon Station, Los Angeles, Calif.

Mid-Continent Section Is Cosponsor of Conference

The Petroleum Fluid Metering Conference was held at the University of Oklahoma on April 11–12, under the joint sponsorship of the A.S.M.E. Petroleum Division, the College of Engineering at the University, and the Mid-Continent Section. Howard Coonley, member A.S.M.E., and chairman of the board, National Association of Manufacturers, gave a talk at one of the Friday sessions on economics and administration.

New Haven Section Has Two Meetings in March

The March 12 meeting of the New Haven Section at Yale University featured a paper on "Surface Finish and the Profilometer," by E. J. Abbott. At the March 19 meeting, F. K. Fischer, Westinghouse Electric & Manufacturing Co., gave a talk on "Superposed Turbine Blade Research."



Joint meeting of Mid-Continent Section of the A.S.M.E. and the Engineers' Club of Tulsa, on March 4, in Tulsa, Okla.
(K. H. Read, metallurgist with the Bethlehem Steel Co., gave an illustrated talk on "The Making of Alloy Steel.")

Minnesota Sections of the A.I.E.E. and A.S.M.E. Hold Joint Meeting

A joint meeting of the Minnesota Sections of the A.I.E.E. and A.S.M.E. was held at the Minnesota Union on March 13. Devoted to the subject of power, the program featured J. T. Rettaliata, Allis-Chalmers Mfg. Co., who spoke on "The Gas Turbine—Neophyte of the Power Industry." The paper was accompanied by slides showing characteristic features and efficiency curves of this type of power installation.

Baton Rouge Members Are Hosts to New Orleans

Arranged by the Baton Rouge members of the New Orleans Section under the direction of Lionel J. Cucullu, program chairman, Will Whittaker, and William Whipple, the March 4 meeting consisted of a luncheon tendered to the members by the Standard Oil Co. of Louisiana at their Baton Rouge refinery; an inspection of the refinery; a visit to the steam plant of the Gulf States Utilities; and dinner in the evening at the Faculty Club of L.S.U. followed by a technical session at which the principal speaker was H. J. Voorhies, Standard Oil Co. of Louisiana, who talked on "Utilization of Refinery Gases in the Production of High-Octane Gasoline."

North Texas Section Members Learn About Superfinish

The subject of "Superfinish" was discussed at the April 3 meeting of the North Texas Section by M. W. Petrie, research engineer, Chrysler Corporation. Dealing with the finishing of bearing surfaces and other wearing parts, the paper was illustrated with slides and samples.

Milwaukee Journal Photo

LINCOLN MEMORIAL DRIVE, MILWAUKEE

(A.S.M.E. Semi-Annual Meeting, Milwaukee, Wis., June 17–20. See pages 418–419.)

325 Philadelphia Engineers Attend March 26 Meeting

The March meeting of the Philadelphia Section on the 26th was opened with a dinner at the Engineers' Club. This was followed by a colored motion picture, "Mechanical Movements in the Manufacture of Iron Pipe, Centrifugally Cast," which was shown through the courtesy of the Florence Pipe Foundry and Machine Co. H. D. Mitchell, of the Link Belt Co., talked to 325 members on the topic of "Positive Mechanical Drives, Reducers, and Speed Changers." Applications for these include the fish ladders of Bonneville Dam and all kinds of industrial machines.

Machine Tool Developments Discussed at Providence

Eric Oberg was the guest speaker of the Providence Section on March 5. He showed slides of recent machine tools, pointing out the most important features of the various designs, particularly those pertaining to ease of operation and drives, such as hydraulic and electrical.

Hydromatic Drive Described to Rochester Section

The Oldsmobile hydromatic drive was described to 208 members and guests of the Rochester Section on March 14 by H. T. Younger, chief engineer, Olds Motor Works. A résumé of the experimental and development work was included in the paper.

Rock River Valley Members Learn About Gas Turbine

J. T. Rettaliata, of the Allis-Chalmers Mfg. Co., discussed the development of the gas turbine to 70 members and guests of Rock River Valley Section at the March 21 meeting. A distinction between the explosion and combustion types of gas turbines was made. Combustion gas turbines built in the United States were shown to the audience by means of slides.

San Francisco Section Has National Defense Meeting

Col. C. H. White and Capt. O. M. Jenks, both of the U. S. Army, were the guest speakers at the "National Defense" meeting of the San Francisco Section on March 28. The two officers presented talks on the present conditions of American ordnance and enumerated the more pressing requirements, in personnel as well as in materials. They said that there is a great need for funds to make possible adequate production of armament for the army.

Powder Metallurgy Subject of Susquehanna Meeting

Gregory J. Comstock, who talked before the Susquehanna Section on March 4, traced the history of powder metallurgy from 1800 to the present. Many products made by this process, such as oil pump gears, were exhibited.

Utah Section Hears Story and Sees Film About Copper

Members of the Utah Section were entertained on Feb. 21 with a five-reel motion picture in color telling about the development and operations of the Utah Copper Co. Running remarks were made by James A. Marsh.

Despite Heavy Competition, Waterbury Has 50 at Meeting

The March 15 meeting of the Waterbury Section was well attended (50) considering that it was a rainy night and there was stiff competition (as Secretary R. B. Bass notes) from the Elks, Lions, Bulls, Bears, Rotary, Kiwanis, and the Foremen's Association, to say nothing of the special excursion to New York City for the flower show. The attraction was E. J. Abbott, who talked on "Surface Finish."

Vocational Training in Virginia for Industry

Virginia Section presented an up-to-the-minute program on Feb. 23 with a talk on "Vocational Training in Virginia" by B. H. Van Oot, who stressed the need of this training as a lack of it is handicapping many industries in the state.

U. S. Navy Takes Over Meeting in Washington

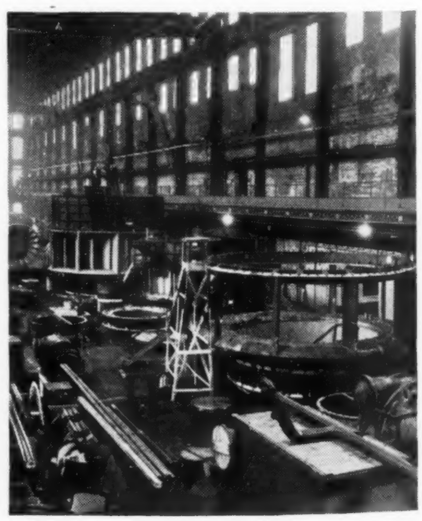
Almost 100 members and guests of the Washington, D. C., Section attended the March 14 meeting which was turned over to the U. S. Navy in the persons of Comdr. W. E. Malloy and Lieut.-Comdrs. E. C. Forsyth and P. W. Haas, who discussed research, design, and maintenance of destroyers.

Aeronautics Talk Features Successful Worcester Meeting

Jerome C. Hunsaker, vice-president A.S.M.E., was the guest speaker at the March 7 meeting, which was attended by 50 members and 100 guests of the Worcester Section. He gave a description of airplanes from 1926 to the present, covering construction, performance, and other points of technical importance.

Friction and Surface Finish Conference at M.I.T., June 5–7

A CONFERENCE will be held at M.I.T. June 5–7, consisting of all-day meetings devoted to the subjects of friction and surface finish. Particulars may be obtained by writing to J. C. Hunsaker, department of mechanical engineering, M.I.T., Cambridge, Mass.



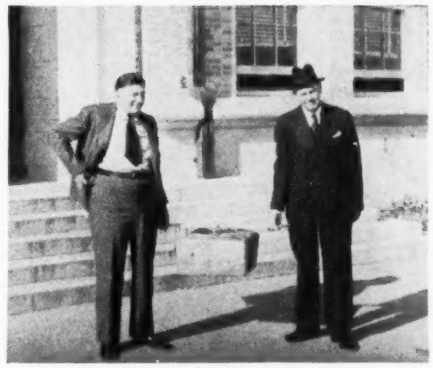
ERECTING FLOOR OF THE ALLIS-CHALMERS MFG. CO. IN MILWAUKEE

(An inspection trip to this plant is planned during the A.S.M.E. Semi-Annual Meeting in Milwaukee, Wis., June 17–20.)

With the Student Branches

6800 Are Enrolled in United States and Canada as A.S.M.E. Student Members

Purdue University Leads List With 246, Followed by Armour With 190 and Illinois With 188



ERNEST HARTFORD, ASSISTANT SECRETARY, AND WARREN H. MC BRYDE, PRESIDENT, A.S.M.E.

(On visit to University of Texas Student Branch. They are carrying between them a bundle of the current copies of Mechanical Engineering.)

THE largest student membership of any engineering society in the world was reached by The American Society of Mechanical Engineers in April, 1940, with 6800 student members in 117 engineering colleges of the United States and Canada. More than 3000 of these students were active participants in the ten regional Student Meetings which were held in various parts of the country during April to give them an opportunity to present technical papers in competition for cash awards exceeding $1000, and other valuable prizes.

Schools With 100 or More

Schools having 100 or more A.S.M.E. student members include Purdue University 246, Armour Institute 190, University of Illinois 188, University of California 173, Texas A.&.M. College 166, University of Minnesota 158, Pratt Institute 135, Newark College of Engineering 121, Case School of Applied Science 120, Massachusetts Institute of Technology 117, University of Michigan 113, Georgia School of Technology 112, Stevens Institute of Technology 105, and Northeastern University 100.

The number of student members enrolled in these and other Student Branches is appended to the following meeting reports, the last to be published in Mechanical Engineering until the opening of schools in September.

Branch Meetings

Alabama Polytechnic Branch (61) had two student papers delivered at the March 18 meeting. One was by Fred Richardson on "Safety for Air Conditioning," and the other by L. R. Loder on "Safety and the Engineer."

Arizona Branch (22) entertained President Warren H. McBryde on Feb. 29. All of the student members enjoyed his talk telling of the place and importance of the mechanical engineer in world affairs.

Armour Branch (190) at its Feb. 23 meeting featured papers by Leon Epstein on the "Fuller Dymaxion House," a futuristic dwelling of unorthodox construction, and by William Yeager on "Industrial Safety."

British Columbia Gives Prizes

At the March 20 meeting of the British Columbia Branch (35), the book prize for the most active and most valuable member was awarded to the retiring secretary-treasurer, Harold J. Morris. Robert Pearce's paper on "Photoelasticity" won the book prize for the best student paper of the year. Upon the suggestion of Garth S. Wade, the Branch's library will be made a depository for all old examination papers as an additional service to student members.

California Branch (173) devoted its meeting of March 14 to the presentation of technical papers by five student members. Another feature of the evening's program was the showing of Pan-American Airways' technicolor-sound motion picture, "Transpacific."

California Tech Branch (67) at its meeting of March 25 selected Gordon Woods and David Steinmetz to represent the Branch at the Student Meeting in Santa Clara.

Catholic University Branch (32) reports that the members were entertained on March 14 by tricks of magic presented by S. B. Ely. Particularly interesting were his comments on spiritualism.

STUDENT MEMBERS OF THE SOUTHERN STUDENT BRANCHES OF THE A.S.M.E. WHO ATTENDED THE 1940 STUDENT MEETING OF THE SOCIETY, HELD IN BIRMINGHAM, ALA., APRIL 1–2, UNDER THE SPONSORSHIP OF THE BIRMINGHAM SECTION

(At the Speakers' Table, left to right: Ernest Hartford, assistant secretary, A.S.M.E; Joseph W. Eshelman, member of Council; E. W. O'Brien, Committee on Relations With Colleges; J. A. Lombard, chairman, University of Alabama Student Branch; Prof. J. M. Gallalee, honorary chairman, University of Alabama Student Branch; R. A. Polglaze, chairman, Birmingham Section; Herbert S. Kent, vice-chairman, Birmingham Section; Dean Samuel B. Earle, member of Council; Prof. Charles R. Hixon, honorary chairman, Alabama Polytechnic Institute Student Branch; F. W. Cayce, chairman, Alabama Polytechnic Institute Student Branch.)

BOTH GROUPS ARE A.S.M.E. STUDENT MEMBERS AT UNIVERSITY OF CINCINNATI

COOPER UNION (EVENING DIVISION) STUDENT MEMBERS ON A RECENT VISIT TO THE M. W. KELLOGG PLANT

IOWA STATE STUDENT BRANCH OF A.S.M.E.

Open Houses

CINCINNATI BRANCH (76) took part in the school's open house on April 6. Many interesting exhibits were shown and lectures given by the student members.

C.C.N.Y. BRANCH (57) did its part on March 29 in the open house which featured exhibits in the various buildings of the School of Technology.

COLORADO BRANCH (36) presented a motion picture dealing with "The Inside Story of Petroleum" at the April 3 meeting. Then Art Lester, Socony-Vacuum Oil Co., described a new gas turbine which had been installed in the company's Wichita plant.

COLORADO STATE BRANCH (28) members at the meeting of Feb. 26 heard Marvin Schaack discuss the discovery and development of carborundum, and Ed. Green review an article in MECHANICAL ENGINEERING.

COOPER UNION EVENING BRANCH (86) had several meetings during March. However, the most interesting was that held on the 29th when Jack Alpert presented a paper on "The Engineer in a Nontechnical Society," and Louis Brooks described "The Effect of Technological Progress on Employment."

A. R. Stevenson at Cornell

A. R. Stevenson, Jr., General Electric Co., spoke before 50 members of the CORNELL BRANCH (85) on "Requisites for Engineering Leadership." His talk followed closely his article of the same title which appeared in a recent issue of MECHANICAL ENGINEERING.

DETROIT BRANCH (65) held a joint meeting with the A.I.E.E. Chapter on March 7. The speaker was E. J. Abbott, member A.S.M.E., who gave a talk on "The Profilometer," an instrument used to measure surface roughness.

IOWA BRANCH (44) had attendances exceeding 50 at each of its March meetings which featured papers by student members. Speakers included Wayne Wallace, J. A. McCaw, F. E. Ash, and H. Cuthbert.

IOWA STATE BRANCH (52) selected Donald C. Ogg, chairman of the Branch, as the most valuable member for 1939-1940. Richard Miller won the prize for the best paper with an article on "Gas Turbines."

Kentucky Makes Survey

In order to discover the point of greatest demand for electricity on the campus, members of KENTUCKY BRANCH (25) have secured four meters from the utility company and are making a study of the problem under the direction of Professor West.

LAFAYETTE BRANCH (35) featured at its March 13 meeting a talk by F. Orthy, president of the Anthracite Club of New York, on "The Economic Problems in the Anthracite Coal Industry."

LOUISVILLE BRANCH (29) had papers by W. R. Loehr, F. W. Eckhardt, and K. H. Scheidt at the March 7 meeting.

MAINE BRANCH (50) announced that Prof. Harry D. Watson, member A.S.M.E., has just been made head of the department of mechanical engineering at the University, succeeding the late Prof. William J. Sweetser.

MARQUETTE BRANCH (31) presented three sound motion pictures on March 5 at a meeting

attended by 40 student members and 110 visitors.

Michigan State Very Active

MICHIGAN STATE BRANCH (80) participated in several activities during March. On the 18th, a movie was shown on the subject of Grand Coulee Dam. Then, on the 27th, Maxwell C. Maxwell was the guest speaker. There was an attendance of more than 200 at the latter meeting.

MICHIGAN TECH BRANCH (72) for its meeting program on March 15 presented papers by Thomas DeFaw, Paul Martin, John Fredd, and Raymond Mattson.

NEVADA BRANCH (19) sponsored several exhibits at the annual "Engineers' Day" held on March 9. Some of the exhibits shown were a petroleum-products display, motorized farming equipment, rotary snow plows, air compressors, trucks, buses, steam locomotive (borrowed from Western Pacific R.R.), motorized trailer, an illuminated fountain, and many others.

NEW MEXICO BRANCH (21) had a special service for Neal Draper, student member, who died on March 30.

NEW MEXICO STATE BRANCH (18) prepared a special exhibit for the St. Patrick's Day celebration at the University on March 17.

Experimental Aircraft at Newark

George Viehmann, Seaboard Aircraft Co., spoke on "Experimental Aircraft" at the March 19 meeting of the NEWARK BRANCH (121).

N.Y.U. AERONAUTICAL BRANCH (31) presented on March 13 as speaker, D. O. Dommasch, who spoke on the subject of "Elementary Synoptic Meteorology." The March 27 speaker was Eugene Mehnert, who discussed "Aircraft Radio Equipment in Modern Air-Line Operations."

NORTH CAROLINA STATE BRANCH (66) took part in the school's annual "Engineers' Fair" on March 30. The affair culminated in a "Grand Brawl" (dance).

NORTH DAKOTA BRANCH (16) celebrated the 60th Anniversary of the A.S.M.E. with a dance in the mechanical-engineering laboratories on April 5.

NORTH DAKOTA STATE BRANCH (20) at its meeting of March 29 had Paul Jones show motion pictures on life and scenes in Mexico. Coffee and doughnuts were served.

Notre Dame Discusses Employment

N. H. Schickel, student member of NOTRE DAME BRANCH (38), gave a talk at the April 2 meeting on "What Has Been the Effect of Technological Advance on Employment?"

OHIO STATE BRANCH (61), after discussing several items of business on March 29, presented a sound motion picture on "The Making and Shaping of Steel."

OKLAHOMA A.&M. BRANCH (29) used the meeting of March 25 as an elimination contest for papers to be presented at the Student Meeting in Lubbock, Texas. Howard Peck and Guy Lentz were the winners.

PRATT BRANCH (135) had two meetings on aeronautics, April 3 and 4. R. T. Howe, Wright Aero. Corp., spoke the first day on the manufacture and testing of aircraft engines. T. P. Gould, American Airlines, showed motion pictures on air transportation during the meeting on the second day.

CALIFORNIA INSTITUTE OF TECHNOLOGY STUDENT BRANCH MEMBERS OF A.S.M.E.

A.S.M.E. STUDENT BRANCH MEMBERS AT MARQUETTE UNIVERSITY

STUDENT MEMBERS AT MONTANA STATE COLLEGE

PURDUE BRANCH (246) members attended a dinner in Terre Haute on March 15 to hear Robert H. Kuss speak on "Municipal Control of Atmospheric Pollution."

R.P.I. BRANCH (86) members heard a lecture on patents by G. H. Bainbridge at the March 20 meeting. Methods of getting and using a patent were described.

S.M.U. Sends Novel Invitation

Sent to Ernest Hartford recently was a postcard from SOUTHERN METHODIST BRANCH (25) which said, "S.M.U. BRANCH wants to CUBA well-informed student on the subject of 'Manu-

A.S.M.E. STUDENT BRANCH MEMBERS AT UNIVERSITY OF MINNESOTA

A.S.M.E. STUDENT BRANCH MEMBERS AT NEWARK COLLEGE OF ENGINEERING

facture of Refractories,' a movie to be presented on March 15."

UNIVERSITY OF SOUTHERN CALIFORNIA BRANCH (35) members are taking part in a new school sport, flying. A school flying team is engaging teams in special meets in which prizes are given for better and finer precision flying. Events include paper-cutting, balloon-bursting, and spot-landing.

TENNESSEE BRANCH (58) member R. S. Anderson gave a paper at the Feb. 22 meeting on the distillation of gasoline.

Texas Welcomes A.S.M.E. Officers

TEXAS BRANCH (70) held a banquet on April 4 in honor of four special guests of the Branch. They were Warren H. McBryde, President of the A.S.M.E.; Ernest Hartford, assistant secretary of the Society; William J. Overton, secretary of the A.S.M.E. Petroleum Division; and M. W. Petrie, research engineer for the Chrysler Corp. Dean W. R. Woolrich introduced Mr. McBryde, who was the principal speaker of the evening. See picture on page 425 which shows Mr. Hartford and Mr. McBryde.

GEORGE WASHINGTON BRANCH (34) was host to the Student Branches of Maryland and Catholic Universities on March 6. The first speaker of the evening was C. E. Davies, national secretary of the A.S.M.E., who spoke briefly on "Engineering as a Profession." The other speaker was A. G. Bissell, senior welding engineer, U. S. Navy, who talked on "Arc Welding." There were 76 people present.

WASHINGTON BRANCH (69) showed at its March 7 meeting a motion picture from the N.A.C.A. on airplane testing. Of great interest to the 53 present were the methods which are used in testing airplane engines in wind tunnels.

Advice to Student Members Who Will Graduate This June

By Alexander G. Christie 1939 President of A.S.M.E.

THE opportunities for employment of graduates in mechanical engineering appear to be more in number than at any time during the last eleven years, with the possible exception of 1937. This indicates that most men will find employment immediately upon graduation. The salaries that are offered this year are also somewhat higher than formerly.

This apparent demand for men may lead to a false feeling of security of employment which may prove disastrous to some at a later date. The war abroad has upset business and normal conditions cannot be expected for some years. At the end of the war, European nations will be exhausted and so greatly in need of foreign trade that our manufacturers will face competition with production at low wages. The inevitable depression will follow.

Self-Development Necessary

To meet such conditions, graduates must resolutely undertake their self-development in order that they may face this situation with assurance that they are "one step" ahead of their competitors. You will ask, "How can this be done?" Much can be accomplished by further study after you take your first job. The training of the undergraduate course, helpful as it is, has proved to be insufficient to meet the needs of modern industry. Business now wants men with the training equivalent to that given in postgraduate years. Those who must secure jobs upon graduation, can get much of this needed training at night schools, by instruction from older men in the industries where they are employed, and by home study. By all means, get this training or later, if times are bad, the young graduate will not be considered to be "one of the indispensable men" in the company's employ.

Membership in A.S.M.E.

Graduates need to develop their personalities and to widen their acquaintances. This can be done effectively by becoming Junior members of the Society upon graduation and by participating in an active way in Junior and other local-section activities. Others have pointed out that the largest incomes are earned by those who direct industries and who control men. Hence that ability to meet, to influence, and to direct people which may be acquired in Society work is a distinct advantage.

Rendering Public Service

As the profession of engineering becomes better recognized, its members will be called upon more and more to render public service. Hence each graduate should early assume his responsibilities as a citizen. He should interest himself in questions of the day and associate himself with a political party in order that he may make his influence felt effectively. At the same time he may be expected to assume the direction of industry and in doing so should apply the same standards of exactness and fair dealing that he expects in purely technical work. Engineering is a life of creative service and one which offers many satis-

factions for jobs well done. May every graduate live to feel that his efforts have been of real value and his life well lived!

Special Courses Announced

ARMOUR INSTITUTE announces a three-term summer graduate institute for engineers covering advanced mechanics, chemical engineering, sanitary engineering, electrical engineering, mechanical engineering, industrial engineering, and applied mathematics. Additional information may be obtained from Dr. L. E. Grinter, Armour Institute of Technology, Chicago, Ill.

COOPER UNION announces that starting next year, the humanities curriculum in the evening division will include six new courses; three, public speaking, American government, and American literature, will be required courses.

COLUMBIA UNIVERSITY announces that a new program of study in the field of mineral dressing will be introduced into the engineering curriculum next year.

UNIVERSITY OF IOWA announces a summer management course devoted to motion and time study, June 10 to 28. Further particulars may be obtained from Prof. R. M. Barnes, College of Engineering, Univ. of Iowa, Iowa City, Iowa.

Engineering Library Has Books and Magazines in 25 Different Languages

All Translations Are Made by Staff at Cost

THE universality of the engineering profession is best illustrated in the Engineering Societies Library, New York, N. Y., by the 25 languages in which its collection of 150,000 books and the more than 1500 periodicals received monthly are published. Of the periodicals, 67 per cent are in English, 12 per cent in German, 8 per cent in French, and 13 per cent in 18 other languages. More than half, 56 per cent, are published outside the United States. The distribution of the number of magazines is as follows:

English-domestic	685
English-foreign	353
French	124
German	192
Italian	25
Japanese	30
Russian	28
Spanish	50
Chinese, Czech, Danish, Dutch, Finnish, Greek, Hungarian, Icelandic, Norwegian, Polish, Portuguese, Rumanian, Swedish, Ukrainian	74

Other languages represented in the book collection include Turkish, Latin, Hebrew, and Arabic.

Many engineers, companies, and institutions doing research work have found in this great library material pertaining to the subject of their research problems. To aid those who are not conversant with foreign languages, the Library maintains a staff of technically trained translators, one of whom is able to translate 20 languages. All translations are made at cost. In order to assure well-written and accurate translations, each job consists of four separate processes, namely, translation, verification by another translator, putting into good English form, and, finally, typing.

Harrison W. Craver, past-president of the American Library Association, is director of the Library.

MEMBERS OF A.S.M.E. STUDENT BRANCH AT MICHIGAN TECH

A.S.M.E. STUDENT BRANCH MEMBERS AT OHIO NORTHERN UNIVERSITY

Inspection of Langley Field N.A.C.A. Laboratories Postponed

SCHEDULED to be held in May, 1940, the annual Aircraft Engineering Research Conference and inspection of the N.A.C.A. laboratories at Langley Field, Va., has been postponed for one year, according to a recent announcement by Vannevar Bush, member A.S.M.E., and chairman of the Committee. The reason given for the postponement to May, 1941, or later, is the great increase in the number and importance of urgent research problems now under way and the greatly increased pressure of work resulting from the effort necessarily devoted to the design and construction of new research facilities for the N.A.C.A. research stations at Langley Field, Va., and Moffett Field, Calif.

1940 Index to Standards of A.S.T.M. Available

THERE has just been issued the latest edition of the "Index to A.S.T.M. Standards, Including Tentative Standards." Containing information about the 561 standards and 324 tentative standards approved as of Jan. 1, 1940, the Index is helpful in locating standard specifications, test methods, and definitions on many engineering materials and subjects. All items are listed in the Index under appropriate key words according to the particular subjects they cover. Copies of this 152-page publication may be obtained by A.S.M.E. members without charge upon written request to A.S.T.M. headquarters, 260 S. Broad St., Philadelphia, Pa.

Junior Group Activities

Philadelphia Juniors Have Fuels Meeting and Trip

THE Junior Group of the Philadelphia Section held a very well attended meeting on March 13, at which Granville C. Martinson, Junior A.S.M.E., and engineer, Sinclair Refining Co., spoke on the subject of burning various fuels efficiently. His talk concerned itself with the firing of steam generators and oil-refinery cracking stills and covered a wide variety of fuels, including various heavy and light oils, coal, and gas. Importance of burner design, atomization, turbulence and mixing, size and temperature of combustion space, and length of flame were discussed and illustrated by means of a motion picture in color. A lively discussion followed the presentation of the paper.

On Wednesday, March 20, the Juniors made a trip to the department store of Strawbridge and Clothier to inspect their mechanical equipment, such as elevators, fans, air-conditioning units, pumps, boilers, compressors, and electrical switchgear. It was very interesting to note the great number of mechanical-engineering problems found in a large department store.

Los Angeles Juniors Present Papers on Surface Finishes

MORE than 175 members and guests were present at the March 14 meeting of the Los Angeles Section which was sponsored, arranged, and presented by the Junior Group. E. Kent Springer, secretary-treasurer of the Section, in his report of the meeting states that Bruce E. Del Mar, chairman of the Junior Group, and his executive committee are to be greatly commended on the organization and presentation of such an excellent program.

Speaking on the general subject of "New Product Surface Finishes," the following Juniors gave papers: "Introduction," by Ralph W. Jones, Byron Jackson Co.; "Porcelain Enamels," by Warde L. Parker, Wagner Morehouse Co.; "Paints, Varnishes, and Synthetics," by Richard B. Esselman, Pacific Railway Equipment Co.; "Metal Surface Plating," by John H. Hanna, American Can Co.; "Spray Finishes," by Wilbur W. Reaser, Douglas Aircraft Co.; and "Plastics Over Metal," by Paul Arnerich, Douglas Aircraft Co. As a surprise feature, Edmond M. Wagner showed a short film made especially for the Section by him during an inspection trip through the American Cast Iron Pipe Co. plant in Birmingham, Ala.

The program was so good that already requests are being made by other local technical societies and associations to have either all or some of the papers presented at their meetings.

Boston Juniors Visit the Harvard Power Plant

SIXTY members of the Boston Junior Group were present at the inspection trip and the preceding group discussion at the Harvard power plant on Feb. 29. A. R. Kenny, chief engineer, and G. K. Saurwein, superintendent of engineering department, Harvard University, led the discussion. Then the Juniors were taken through the plant in small groups. Steam and power are supplied from this one point to 12 cooperative institutions, including the Harvard medical, dental, and public health schools, Children's Hospital, Peter B. Brigham Hospital, and others.

A.F.A. Annual Meeting in Chicago, May 6–10

THE annual convention of the American Foundrymen's Association to be held in Chicago, May 6–10, 1940, will present a series of 21 technical, management, and shop-operation sessions. General interest subjects include foundry refractories, plant equipment, sand research, apprentice training, foreman training, safety, health programs, job evaluation, time study, and patternmaking. In addition, each of the major divisions, namely, gray iron, steel, malleable, and nonferrous, are scheduling several sessions each for the presentation of papers covering research and practices in the production of various types of castings.

Cushing

MILWAUKEE IS DISTINCTIVE FOR THE RIVER RUNNING THROUGH THE CITY

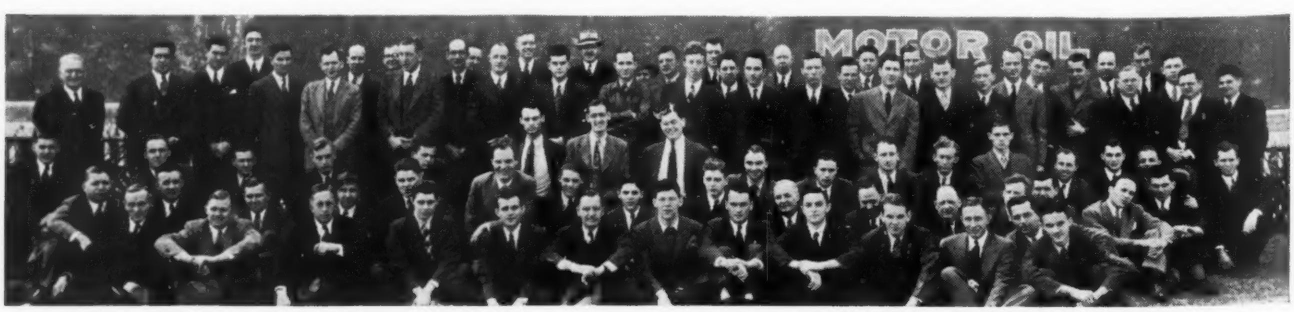
(See pages 418–419.)

Musicale Held for Rice Fund by Woman's Auxiliary to A.S.M.E.

THE National Board of the Woman's Auxiliary to the A.S.M.E. held its March session in the Society's rooms on March 14. Mrs. Collins P. Bliss, the first vice-president, was in the chair owing to the absence of the president, Mrs. George W. Farny. The meeting later adjourned to the Engineering Woman's Club for luncheon and to attend the benefit for the Calvin W. Rice Scholarship Fund.

The Board of the Metropolitan Section of the Auxiliary met in the forenoon at the Engineering Woman's Club and Mrs. E. C. M. Stahl, the chairman, announced the following appointments as chairmen of committees: Mrs. A. M. Feldman, Ways and Means; Mrs. C. B LePage, Membership; Mrs. E. A. Salma, Hospitality; Mrs. Earl Smith, Publicity; and Mrs. C. H. Kent, Program.

The first benefit of the Metropolitan Section for the Calvin W. Rice Scholarship Fund was a musicale. The artists were Miss Ruth Welles, soprano, and Lawrence Ellinger, accompanist and entertainer. A large audience enjoyed this delightful treat and the tea which was served later by Mrs. Calvin Rice and Mrs.



NEW ORLEANS MEMBERS OF THE A.S.M.E. VISIT THE PLANT OF THE STANDARD OIL CO. OF LOUISIANA, MARCH 4, 1940

Stahl. To Mrs. Feldman and her committee, thanks are due for a most enjoyable afternoon and the Fund is the gainer by $35.

On April 11 at the Engineering Woman's Club, the Metropolitan Section held its monthly meeting. The guest speaker was Mrs. Edith R. Young, Vogue Pattern Service, who spoke on "Pattern Design and the New Fashions," always an intriguing subject.

Pi Tau Sigma Observes 25th Anniversary

ORGANIZED at the University of Illinois, March 16, 1915, Pi Tau Sigma, national mechanical-engineering honorary fraternity, observed its 25th anniversary by issuing a silver-anniversary number of its official magazine, *The Condenser*. Howard E. Degler, member A.S.M.E. and professor of mechanical engineering at the University of Texas, edited the 52-page publication.

Dr. Gilbreth Is Honored by Engineering Woman's Club

ONE of the well-known members of the A.S.M.E., Lillian M. Gilbreth, who is president of Gilbreth, Inc., and professor of management at Purdue University, was made an honorary life member of the Engineering Woman's Club, New York City, at a dinner given in her honor on March 22. The citation, read by Mrs. Harvey Fletcher, president of the club, summed up Dr. Gilbreth's achievements in many lines as follows: "For your scientific achievements in the field of industrial psychology, for your pioneer work in applying these principles to the practical problems of the efficiency of human labor; for your intelligent womanhood; and for the esteem in which you are held by your fellow members."

The chief address was given by Allan R. Cullimore, member A.S.M.E., and president of Newark College of Engineering, who stressed not only Dr. Gilbreth's scientific accomplishments but the fact that they had involved no sacrifice of personal or domestic success. Dr. Gilbreth, after thanking the club and Dr. Cullimore, directed attention to the traditional generosity of the engineering profession in the United States to women.

LILLIAN M. GILBRETH

T. H. HOGG, INCOMING PRESIDENT OF THE ENGINEERING INSTITUTE OF CANADA ADDRESSES THE GUESTS AT THE PRESIDENTS'S DINNER, ENGINEERS' CLUB, TORONTO, CANADA, FEB. 7, 1940, IN CONNECTION WITH THE ANNUAL MEETING OF THE INSTITUTE

(At Dr. Hogg's right is Warren H. McBryde, president A.S.M.E. The others are (left) Dean H. W. McKiel, president E.I.C., 1939, and (right) J. W. Rawlins, president, Association of Professional Engineers of Ontario.)

American Engineering Council

Presents

The News From Washington and Elsewhere

Celebrate 150th Year of Patent Law

BY action of Congress and President Roosevelt April 10, 1940, was designated Inventors and Patents Day to commemorate the sesquicentennial of the approval of the first patent law of the United States, signed by President George Washington on April 10, 1790.

The occasion was marked by a large dinner in Washington, attended by about a thousand leaders of industry, science, government, and the patent bar. Invitations were issued to the entire membership of the A.E.C. executive and patents committees, and the dinner was attended by President Alonzo J. Hammond, Vice-President William L. Batt, and Executive Secretary Frederick M. Feiker.

As part of the celebration the Patent Office kept open house for the entire week and staged a "Parade of Inventions," specially prepared exhibits on the development of industrial products from medieval times to the present.

TNEC Opens Hearings on Technologic Changes

ON April 8 the Temporary National Economic Committee began a new series of hearings, expected to extend over a period of some three weeks, to develop information on the broad subject of technological change and its effect on employment and production. Invited to testify were over 40 leaders of science, industry, and organized labor in the fields of automobile manufacture, steel, coal, railroads, textiles, communications, office appliances, agriculture, and vocational and consumers' education.

In announcing the hearing Senator Joseph C. O'Mahoney, chairman of the committee, pointed out: "Without modern technology, mass production would not be possible; it is technology which has enabled industry to organize into great concentrated units of production and distribution. Technology has created many new industries and has provided many new opportunities for labor, though at the same time it has unquestionably displaced many workers. The committee plans to study seriously the impact of technology in all its implications, what it means in terms of employment, of unused capital, of the effective organization of our nation's resources."

The chairman also made it clear that the committee entered its task with no pre-formed judgments, and that the hearings were not intended to express support for his recently introduced bill to provide a system of rewards and contributions for the greater utilization of labor in industrial production through the taxing of machines.

Last month the TNEC completed a series of hearings on the effects of various state regulations on interstate commerce.

New Developments Mark Aviation Progress

THREE recent accomplishments in the field of aviation emphasize the speed with which technology in this field is progressing,

and give point to the argument of Army and Navy officials that they will lose nothing by yielding temporary priority to foreign nations in the delivery of aircraft orders.

The U. S. Navy, it has recently been disclosed, has under construction by the Glenn L. Martin Company, Baltimore, a giant "flying houseboat" that will weigh nearly 84 tons, carry a useful load of 32 tons, and be capable of a nonstop flight of over 12,000 miles. This machine slightly surpasses the Army's biggest ship, also under construction, which will have a gross weight of 70 tons and a useful load of 28 tons. Both planes will be more than twice the size of the Army's famed "flying fortresses."

Although details of the power plants to be used were not made public, aviation experts link the new planes with the recent development of a new nine-cylinder air-cooled motor rated at 1200 horsepower, or approximately one horsepower for each pound of its weight.

A third notable development was the successful completion on April 6 of a 300-mile all-blind flight in an Army bombing plane from Mitchell Field, N. Y., to Langley Field, Va. The four-motor, $22^1/_2$-ton machine was guided entirely through instruments, with the pilot hooded, from before the take-off until after the landing.

Sayers Named Director of Bureau of Mines

Dr. R. R. Sayers, senior surgeon of U. S. Public Health Service, who for 17 years directed the health and safety activities of the Bureau of Mines, has been appointed acting director of the Bureau to succeed John W. Finch, who resigned January 31.

Pan-American Relations Promoted by Council

As the result of the interest in stimulating relations with the countries of Central and South America stirred up by discussion at the Twentieth Annual Assembly of American Engineering Council last January, two tangible accomplishments have already materialized. The Farm Equipment Institute Seminar, to be held in September, 1940, will reserve places for six Pan-American representatives; and Council itself is forming a new Committee on Inter-American Engineering Relations.

The Seminar, which is sponsored by a group of agricultural-machinery manufacturers with the cooperation of the American Society of Agricultural Engineers, comprises a group of 112 agricultural students and instructors who, as guests of the manufacturers, are conducted on a one-week tour of industrial establishments making farm equipment. The six Pan-American participants will be selected by the U. S. Department of State as representatives of agricultural schools in as many countries.

Council's new committee, the formation of which has been approved by the Executive Committee, will not only facilitate the completion of arrangements with the State Department in regard to the Seminar, but will also function as a standing committee to improve contacts between engineers of the nations within this hemisphere. Suggested subjects for action include the exchange of students, lecturers, and professors; the development of conferences and correspondence among organized engineering groups in the various countries; and possibly the promotion of a Pan-American Engineering Congress at some future date.

Patent Inquiry Completed

Following nearly a year of intensive study of the American patent system the staff of the Joint Patent Inquiry, sponsored by the National Association of Manufacturers, The Conference Board, and American Engineering Council, on March 15 completed its work with the submission of a lengthy report to the three organizations.

Among the topics discussed are the changing sources of invention and the rising importance of the industrial research laboratory; the social and economic benefits of invention; patent procedures and practices; industry's use of patents; evolutionary changes in the patent system and their effects upon the inventor, industry, and the public; and the merits and drawbacks of proposed reforms.

Power Grid Proposed for Eastern United States

After nearly two years of study by the National Defense Power Committee and its successor, the National Power Policy Committee, a definite plan for the linking of power-generating and load centers in the northeastern section of the United States has been prepared and submitted for comment to the leading utility companies operating in the area concerned.

The plan envisions the construction by the government of a series of 275,000-volt circuits connecting the following cities: Washington and Baltimore with Boston via Philadelphia, New York City, and Bridgeport; Philadelphia and Pittsburgh; New York City and Cleveland via Binghamton, Syracuse, and Buffalo; Pittsburgh and Chicago via Cincinnati and Indianapolis; Pittsburgh and Chicago via Cleveland and Toledo, with a branch to Detroit; Chicago and St. Louis via Powerton; and Chicago and Milwaukee.

Approximately 2500 miles of line would be involved with a total estimated cost of $190,000,000 including $70,000,000 for transformers and $50,000,000 for connections with present operating systems. Annual operating costs would amount to about $13,000,000, of which some $9,000,000 would be met by revenues for the use of various parts of the system to interchange power.

Personnel Selected for A.E.C. Committees

Many prominent engineers have accepted invitations by President Alonzo J. Hammond to serve on the various committees of American Engineering Council for the year 1940. Chairmen of the standing and special committees include the following: *Constitution, By-Laws, and Standing Rules*, Edwin F. Wendt, Pittsburgh, Pa.; *Engineering and Allied Technical Professions*, C. O. Bickelhaupt, New York, N. Y.; *Finance*, F. Malcolm Farmer, member A.S.M.E., New York, N. Y.; *Membership and Representation*, Warner Seely, member A.S.M.E., Cleveland, Ohio; *Publicity and Publications*, Eugene W. O'Brien, past vice-president A.S.M.E., Atlanta, Ga.; *Regional Activities*, James R. Withrow, Columbus, Ohio; *Public Affairs*, Alvan L. Davis, member A.S.M.E., Waterbury, Conn.; *Patents*, A. A. Potter, past-president A.S.M.E.; *Public Works*, George W. Burpee; *Surveys and Maps*, John S. Dodds; *Engineering Economics*, L. J. Fletcher; and *Inter-American Engineering Relations*, C. O. Bickelhaupt.

Men and Positions Available

Send inquiries directly to Engineering Societies Employment Service 29 West 39th St., New York, N. Y.

MEN AVAILABLE[1]

MECHANICAL SUPERINTENDENT, 49, married. University graduate now employed. Twenty years' experience in directing plant maintenance, construction, and power-plant operation. Last 10 years in chemical industry in Philadelphia area. Me-456.

ENGINEER, licensed, 46. Twenty years in responsible charge of design, steam condensers, thermal compressors, steam-jet refrigeration, vacuum pumps, hydraulic circuits, deaerators. Also sales experience and patent record. Me-457.

MECHANICAL ENGINEER, graduate M.E. 1936, married, 27. Now employed. Experience in tool design, time study, and product design in plants manufacturing interchangeable parts. Interested in costs. Me-458.

DEVELOPMENT ENGINEER, 28, B.S.M.E., married. Six years of experimental, development, and research work; machinery erection, maintenance; cost reduction; product development; production supervision. Desires new connection in East with active future. Me-459.

MECHANICAL ENGINEER, 1939 graduate, B.S., 22. Since graduation employed as inspector of machine parts and machine-shop operations; good draftsman. Also interested in machine design. Me-460.

MECHANICAL ENGINEER, graduate, 31, married. Seven years' production control, mate-

[1] All men listed hold some form of A.S.M.E. membership.

(*A.S.M.E. News continued on page 434*)

rial testing, customer problems, plant engineering. Two years sales. Now employed. Prefer sales or plant control work in New England. Me-461.

MANUFACTURING PLANT MANAGER, chief engineer, 38, graduate. Advanced business-administration studies; organizer and coordinator with background of plant and industrial engineering in process and assembly industries. Now employed. Me-462.

MECHANICAL ENGINEER, graduate, 38, advanced degree. Broad experience teaching engineering abroad and America. Also experienced design, construction experimental engineering apparatus. Desires professorship experimental engineering or heat power. Me-463.

CHIEF DRAFTSMAN, DESIGN ENGINEER, 37, married, German engineering degree. Thirteen years' experience design of chemical and allied industrial machinery and plants from detail to project layout. Good coordinator and supervisor. Me-464.

EXECUTIVE ENGINEER. Thirty years' responsible charge wide variety mechanical engineering, specializing in material-handling equipment, heavy machinery, all kinds gates, cranes, and accessories for hydroelectric projects. Seeks new connection. Me-465.

MECHANICAL ENGINEER, Louisiana State 1939. Experienced in statistics, production control, maintenance. Presently employed. Desires permanent connection with company in airplane or allied industry. Single, 26. Location, secondary. Me-466.

POSITIONS AVAILABLE

BOILER DESIGNER who is thoroughly experienced in designing bent-tube, water-tube boilers. Location, Pennsylvania. Y-4867.

MECHANICAL ENGINEER, 27–32, with approximately 5 years' experience. Must have some experience in design and layout of hydraulic fittings, such as used in sprinkler systems, power piping. Must know how to calculate stresses and strength of parts. Work will be in laboratory of large manufacturing company. Salary, $150–$200 month. Location, New England. Y-5458.

DESIGNER-DRAFTSMAN, 30–45, with experience on hydraulic pumps, transmissions. Must know technical German in order to use German drawings. Salary, $250 a month. Location, Middle West. Y-5477C.

SALES ENGINEER who has experience in sales to industry. Man familiar with conveying and screening machinery preferred. Location, New York, N. Y. Y-5488.

SHOP PROFESSOR, 35–45, with varied and extensive experience, competent to supervise shops and instruction therein in engineering college. Salary, $3500 a year. Location, New York State. Y-5489.

CALCULATOR for turbine-engineering department; graduate of recognized engineering college, one or two years out; thorough undergraduate training in thermodynamics and allied subjects essential. Work will involve engineering and design calculations in connection with steam-turbine proposition work, staging performance, testing, etc. Location, Pennsylvania. Y-5490.

GRADUATE MECHANICAL ENGINEER, 35–40, experienced in design and development of both heavy and light equipment and semiautomatic machinery. Applicant will have to start on the board. Location, East. Y-5499.

MECHANICAL ENGINEER, 35–45, to head engineering department of company manufacturing small standard metal article. Duties: Study and redesign of present product; design of new product; pure research. Applicant must have sufficient plant experience (practical) so that he has thorough knowledge of tools, dies, jigs, and fixtures. Location, Conn. Y-5501.

PRODUCTION CONTROL ENGINEER to install and operate modern, efficient, production-control system in stove plant. Applicant must know shop practice thoroughly, must be acquainted with tools and dies, and must be thoroughly trained in installation and supervision of routing the product and handling materials in manner productive of the minimum investment in inventory and elimination of delays caused by shortages and other problems which develop in plant operation. Location, Middle West. Y-5505C.

TOOL DESIGNER thoroughly familiar with modern production methods, preferably man connected with machine-tool industry or its equivalent. Applicant must be able to estimate cost of manufacturing without tooling as compared with tooling, estimate cost of jigs, fixtures, dies, and tools, as well as make layouts, design, and make detailed drawings and specifications for the tools. Salary open. Location, Pennsylvania. Y-5509.

MECHANICAL ENGINEER, young, who can make calculations in connection with torsional vibrations; one to three years' experience desirable but not essential. Applicant must be especially good mathematician. Location, New York State. Y-5516.

SALES ENGINEER, 30–40, with several years' selling experience. Should also have background in boilers, pressure vessels. Will sell safety valves and appliances to petroleum companies, refineries. Salary, $150–$200 a month. Location, New York, N. Y. Y-5519.

SALES ENGINEER, graduate E.E. or M.E. from accredited university, over 35. Engineering experience should include engineering and field service with equipment such as railroad signals, electrical recording instruments. Sales experience should include sales contacts over period of years with engineers and executives of industries, preferably railroad and steel mills; should also have sales organization experience. Opportunity. Location, East. Y-5537.

PRODUCTION DESIGN ENGINEER, 35–40, to work as specialized project production engineer; might eventually become chief of all production design. Should have ten years' experience in production-design work. First principal duty would be to design production bus transmission. In the organization he would work between research and development engineers and shop. Opportunity. Salary open. Location, Middle West. Y-5538C.

ASSISTANT CHIEF ENGINEER, graduate mechanical, electrical, or chemical engineer, with 10 to 15 years' experience in production organization involving problems similar to those encountered in food industry, with respect to type of building construction and product-handling equipment. Must be able to take charge of steam and electrical plant; to make industrial layouts; to supervise special machine development and design; to supervise, with aid of chief draftsman, drafting force of 20–30 men; to show general knowledge of heating and ventilation of manufacturing buildings, particularly with reference to removal of steam, as from cooking operations. Location, New Jersey. Y-5540.

SALES, SERVICE, AND APPLICATION ENGINEER, single. Package or self-contained air-conditioning experience; will be manager of department. Location, Far East. Y-5549.

DESIGNER, 35–50, married. Experienced on sheet-metal-working machinery, squaring shears, presses, forming rolls, and folders. Salary, $50–$75 a week. Location, Connecticut. Y-5556.

MECHANICAL ENGINEER, 30–40. Applicant must have specialized in machine-shop work on speeds and feeds, rate setting; speed boss in machine industry would qualify. Salary, $4000–$6000 a year. Location, New York State. Y-5558.

GRADUATE MECHANICAL ENGINEER, under 40, with about 10 years' experience in maintenance and factory work; also experience in design relative to new installations. Applicant should also be familiar with steam power

(*A.S.M.E. News continued on page 436*)

30,000 Engineering Positions Have Been Filled

An article with the above title, written by A. H. Meyer, executive secretary of the Engineering Societies Employment Service, appears on page 390 of this issue.

Patience Rewards A.S.M.E. Member With $6000 and $5000 Positions

AN A.S.M.E. member lost his position in 1931 and immediately registered with the Engineering Societies Employment Service for a new job. After waiting for 30 days, he was sent out to interview a prospective employer, who, after checking over the experience and qualifications of the applicant, hired him as his chief engineer at $6000 a year.

This position lasted until November, 1939, when the member again registered with the Service. Positions were more plentiful then than in 1931, but there were none for him. He waited; days, weeks, and months passed. Finally in March, 1940, a position was listed for which he had the necessary qualifications. Upon his first interview, he got another position as chief engineer, this at $5000 a year.

According to A. H. Meyer, executive secretary of the Service, this case illustrates the fact that sometimes it takes a little time before one obtains the position for which he is looking, while others are so lucky as to get a position the first day they register. But, he emphasizes, no man can hope to get a high-salaried position unless he has the necessary experience and qualifications.

plants. Salary, $50 a week. Location, New York, N. Y. Y-5569.

MANAGER, 40–55, for newsprint and box-board plant. Applicant must be Canadian citizen but experience gained in United States would be desirable. Y-5580.

PRODUCTION CONTROL SUPERVISOR, graduate mechanical engineer, not over 40, for machine-tool manufacturer. Will have complete charge of routing, scheduling, rate setting, etc. Salary, $3600 a year. Location, Pennsylvania. Y-5597.

CHIEF DRAFTSMAN, 35–50, with experience in machine-tool design. Should have experience with milling machines. Must be good executive. Salary up to $4000 a year. Location, Pennsylvania. Y-5598.

CHIEF ENGINEER for company manufacturing a-c and d-c motors up to 5000-hp capacity. Location, Japan. Y-5604.

FACTORY MANAGER, well-versed in machine-shop work in milling, drilling, grinding, punch press, medium to small intricate assembly work. Also must know thoroughly methods of planned production and coordination of costs, inventory control; must possess good personality and have ability to lead. Nonunion shop of about 300 male employees; working conditions excellent. Salary, $100 a week to start. Location, East. Y-5616.

PLANT-METHODS ENGINEER, graduate mechanical or electrical engineer, not over 40, with extensive experience in diversified consumer-goods industries. Must be thoroughly grounded in practical machine operations. Must have ability to appraise factory operations and recommend and install corrective procedures. Traveling necessary. Salary, $5000–$6000 a year. Location, New York, N. Y. Y-5619.

DIESEL ENGINEER, not over 35, who has from five to ten years' experience in Diesel-engine operating and maintenance problems. Applicant will be required to travel to Mexican plants to aid them in their problems. Must be able to speak Spanish. Salary, $3600–$4000 a year. Y-5626.

POWER-PLANT SUPERINTENDENT not over 45, to operate a small 6000-kw, five-boiler, oil-fired power plant in Mexico. Must have about 10 years' experience and be capable of solving boiler-plant operating and maintenance problems. Should be able to speak Spanish. Salary, $3600–$4000 a year. Y-5627.

GRADUATE ENGINEER, mechanical or electrical, capable of designing and selecting general manufacturing equipment, preferably engineer who has five years' paper or felt-mill experience or who has worked for company manufacturing asphalt-roofing products. Applicant must have executive ability. Opportunity for advancement. Salary, $300 a month. Interview in New York, N. Y. Location, New York State. Y-5630.

MECHANICAL ENGINEER with some practical engineering experience in design and manufacture of locks. Company manufactures all types of locks, including built-in as well as padlocks and watchman's clock systems. Salary open. Location, Middle West. Y-5648.

ENGINEER, preferably single, who has specialized in petroleum production, methods of production, transportation and drilling, either pumping or gas-lift experience. Salary around $500 American money; three-year contract; passage and expenses both ways; three weeks annual vacation. Location, South America. Y-5653-S.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after May 25, 1940, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

In addition to the names given are a group of approximately 2600 transfers from Student Member to Junior Member, whose names will appear on a May Ballot to Council.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ABRAMOSKI, JAS. W., Cambridge, Mass.
BACHMAN, WALTER C., Kew Gardens, L. I., N. Y.
BARBER, N. H., Pittsburg, Calif.
BILOCQ, GEO. A., Plessisville, Quebec, Can.
BUMSTEAD, ROBERT, Philadelphia, Pa.
CATLIN, WELLES G., Scranton, Pa.
COBB, EDWIN A., New York, N. Y.
CREEL, WM. H., Bartlesville, Okla.
DANNER, WM. J., Louisville, Ky.
DIXON, E. O., Milwaukee, Wis.
ENNIS, ROBERT L., Lawrenceburg, Ind.
FELIX, SAML. P., JR., Trenton, N. J.
FOLKE, BENGT E., New York, N. Y.
GREEN, JOHN, Greensboro, N. C.
HALE, F. A. W., Lawrenceburg, Ind.
HAMMERSHAIMB, GEO. T., Milwaukee, Wis.
HATCH, ALBERT M., Hingham, Mass.
HEBERT, A. J. G., Plessisville, Quebec, Can.
HILL, ROWLAND C., Fitchburg, Mass.
HILSTROM, RAGNAR T., New York, N. Y.
HOLLOWAY, FRANK M., New York, N. Y.
HUNG, CHAN BING, Hong Kong, China
KACZYNSKI, ZYGMUND, Detroit, Mich.
KALKHOFF, AMOS W., Lawrenceburg, Ind.
KRAUSE, CARL H., Brooklyn, N. Y.
LEINS, RICHARD W., Louisville, Ky.
LILLIE, HERBERT, Montreal, Quebec, Can.
LOWELL, CHAPIN M., Canton, Ohio
MCKENDRICK, LESLIE, St. Davids, Pa.
PICKLE, QUINTON L., Tulsa, Okla.
RUSHING, F. C., East Pittsburgh, Pa.
SCHAFFERT, GEO. A., Forest City, N. C.
SCHMITT, GEO. H., JR., New Orleans, La.
SPAULDING, JOHN D., New York, N. Y.
TRIPLETT, J. L., Marshall, Tex.
VIALL, RICHMOND, Providence, R. I.
WALTER, JOHN M., Cincinnati, Ohio
WEBER, WM. R., Cape Charles, Va.
WELSH, ERNEST J., Halethorpe, Md.
WILLIAMS, CHESTER E., Worcester, Mass.

CHANGE OF GRADING

Transfers to Fellow

PARKER, J. C., Brooklyn, N. Y.
SNAVELY, A. BOWMAN, Hershey, Pa.

Transfers to Member

ELLENBERGER, WM. J., Washington, D. C.
MAULBETSCH, JOHN L., Brooklyn, N. Y.

Transfers from Student Member to Junior—20

A.S.M.E. Transactions for April, 1940

THE April, 1940, issue of the Transactions of the A.S.M.E. contains the following papers:

TECHNICAL PAPERS

A Supersensitive Governor for Hydraulic Turbines, by W. M. White
Power Swings in Hydroelectric Power Plants, by W. J. Rheingans
Generator Characteristics as Affecting System Operation, by S. H. Wright
Steam-Turbine Governors, by R. J. Caughey
Constant System Speed and the Steam-Turbine Governor, A. F. Schwendner
The Field of System Governing, by Albion Davis
Regulation of System Load and Frequency, by Herbert Estrada and H. A. Dryar
Experiences in System Speed Regulation, by Otto Holden
Two Years' Experience With High-Temperature High-Pressure Stations:
High-Temperature High-Pressure Superimposed Installations at Waterside Station, by J. C. Falkner
Fisk Station Topping-Unit Operation, by A. E. Grunert
Logan Operating Experience, by Philip Sporn
Superposed Installation at Omaha Station of Nebraska Power Co., by Louis Elliott

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

BLACKBURN, ARTHUR H., January 27, 1940
COTTON, GEORGE G., March 5, 1940
ELLIOTT, GEORGE F., January 22, 1940
KEENAN, WALTER F., JR., March 18, 1940
LANDFEAR, GEORGE H., February 19, 1940
STANGLAND, BENJAMIN F., March 26, 1940
WILLSON, FREDERICK N., November 15, 1939